COLORADO RIVER
PART 417 SUBMITTAL

Information, Comments, and Suggestions
Concerning IID's Estimated Water Requirements
For Calendar Year 2003

Submitted To
United States Department of Interior
Bureau of Reclamation

Submitted By
Metropolitan Water District of Southern California

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I. INTRODUCTION

By letter dated September 9, 2002, the Imperial Irrigation District ("IID") requested permission from the United States Department of Interior, Bureau of Reclamation ("DOI/BOR") to divert 3.10 million acre feet ("MAF") of water from the Colorado River at Imperial Dam, as well as 104,000 acre feet of Colorado River water at Parker Dam. IID stated that its request was "based upon the latest predictions of rainfall, as well as, likely 2003 cropping patterns including multiple cropping." See Letter from Jesse P. Silva, General Manager, Imperial Irrigation District, to Ruth Thayer, United States Department of Interior, Bureau of Reclamation (Sept. 9, 2002) [hereinafter "IID Diversion Request"].

By letter dated December 27, 2002, DOI/BOR informed IID that it would be permitted to divert a total of only 2.85 MAF at Imperial Dam in 2003. DOI/BOR's decision was made after consulting with IID and other water users pursuant to Title 43, Part 417 of the Code of Federal Regulations ("Part 417"), and was based on a number of considerations, including the absence of any surplus Colorado River water for 2003. More importantly, DOI/BOR's decision was based on its determination that 2.85 MAF was more than sufficient to meet IID's beneficial use needs. See Letter from Bennett W. Raley, Assistant Secretary for Water and Science, United States Department of the Interior, to Jesse P. Silva, General Manager, Imperial Irrigation District (Dec. 27, 2002) [hereinafter "Original Water Order"].

On January 10, 2003, IID filed a lawsuit challenging the Original Water Order. Among other things, IID asserted that DOI/BOR had failed to follow the procedures set forth in Part 417 in determining the amount of Colorado River water IID was entitled to divert. Although DOI/BOR vigorously denied this assertion, the district court concurred with IID. The court enjoined DOI/BOR from enforcing the Original Water Order and remanded the matter to DOI/BOR to conduct a *de novo* Part 417 review. See Imperial Irrigation District v. United States, USDC, Southern District of California, Case No. 03-CDV-0069W(JFS) [hereinafter "IID Litigation"].

Accordingly, on April 28, 2003, DOI/BOR revised the Original Water Order to incorporate IID's request to divert 3.10 MAF of Colorado River water ("Revised Water Order"), pending completion of the required Part 417 review. See Letter from Bennett W. Raley, Assistant Secretary for Water and Science, United States Department of the Interior, to Jesse P. Silva, General Manager, Imperial Irrigation District, et al. (Apr. 28, 2003) [hereinafter "Revised Water Order"].

On April 29, 2003, DOI/BOR issued a notice in the *Federal Register* inviting all interested parties to submit any information that might be relevant to DOI/BOR in determining IID's estimated water requirements for calendar year 2003. More specifically, the notice stated, "Timely written information, comments and suggestions which relate to the recommendations and determinations required of the Regional Director [of BOR] under 43 CFR 417.2 or to the factors listed in section 417.3 will be considered relevant." DOI/BOR has established a 30-day period (until May 29, 2003) for submission of such information. See 68 Fed. Reg. 22738 (Apr. 29, 2003).

Consonant with this invitation, the Metropolitan Water District of Southern California ("Metropolitan") hereby submits the following information, comments and suggestions for consideration by DOI/BOR ("Part 417 Submittal").[1] Our Part 417 Submittal consists of two principal components.

The first component is this document, which attempts to summarize and collate all of the information developed and conclusions reached by our nationally-renowned team of outside technical consultants and in-house technical staff ("Metropolitan Expert Team") concerning IID's water requirements for 2003.

We begin by briefly revisiting the subject of reasonable beneficial use. Reasonable beneficial use is the overarching legal standard applicable to the Part 417 process and, as such, provides the backdrop against which any analysis of IID's water requirements must occur. We then review the basic principles and specific factors that must guide DOI/BOR's analysis under Part 417. We do this because all too often IID has attempted to cloud this process with issues that have no bearing on the key question here: How much water does IID need to satisfy its reasonable beneficial uses? Next we provide a summary of the detailed analyses conducted by the Metropolitan Expert Team and in-house staff of the Part 417 factors, as they apply to IID's water use. This discussion is broken down into three main areas of focus: current water requirements, historical water use, and future water conservation opportunities. Finally, we provide our recommendations for an appropriate water order for IID.

The second component consists of the actual memoranda and reports prepared by the Metropolitan Expert Team, which serve as the foundation for this Part 417 Submittal. These memoranda and reports are grouped by author under Tabs 1 through 9, in roughly the order they are discussed in this summary document. These memoranda and reports are accompanied, where appropriate, by a supporting declaration and current curriculum vitae.

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[1] The *Federal Register* notice indicates that DOI/BOR will consider all materials and declarations that have been submitted as part of the IID Litigation and that "it will not be necessary for IID, the State of California or any other interested party to file with Reclamation as part of this Part 417 consultation any material which has been filed or lodged with the court in [the IID] case." 68 Fed. Reg. at 22738. Accordingly, Metropolitan simply incorporates by this reference all of the pleadings, declarations, exhibits and information that it previously submitted to the district court in the IID Litigation.

The Metropolitan Expert Team has more than 200 years of collective experience in these areas of agricultural sciences and economics, crop growth and management, and irrigation and conservation techniques, and includes some of the foremost authorities in these fields. This team includes:

- **Richard G. Allen, Ph.D.** Dr. Allen is a consultant in the fields of irrigation engineering, hydrology and water resources engineering. He has over 25 years experience in irrigation systems design and hydrologic modeling, including calculation, prediction and measurement of evapotranspiration and irrigation water requirements and quantification of irrigation uniformity and efficiency.

- **F. Bruce Brown** Mr. Brown is a resource economist with 29 years of professional experience. He specializes in the economic, financial, social and land components of natural resource development projects. His specific areas of expertise include the analysis of economic and financial influences and effects; environmental assessments and impact statements; and the identification and evaluation of beneficial and adverse impacts to population, employment, fiscal budgeting, and local and regional economies.

- **Kirk Dimmitt** A. Kirk Dimmitt is a Principal Engineer employed by Metropolitan since 1990 and is based in El Centro, California in the Imperial Valley. Mr. Dimmit's primary responsibility is as Metropolitan's Project Manager of the IID-Metropolitan water conservation program, in which he is responsible to review and approve all planning, design, and construction of fifteen water conservation projects within the IID. Mr. Dimmitt is responsible for coordinating the efforts of the team of independent experts retained by Metropolitan to study water use and management issues within the Imperial Valley.

- **Byron C. Gabrielsen, Ph.D.** Formerly a Research Agronomist with the United States Department of Agriculture, Agronomy Research Service, Dr. Gabrielsen is a consultant in the areas of agronomy and crop production in the Imperial and Central Valleys of California. Dr. Gabrielsen has 20 years of experience in crop nutrition and irrigation management; soil remediation and management; land assessment for agricultural uses; water resources evaluation; and general crop production. Dr. Gabrielsen is licensed as a state and national Certified Crop Advisor by the American Society of Agronomy.

- **Mark E. Grismer, Ph.D.** Dr. Grismer has been a professor of hydrology and biological and agricultural engineering for nearly 20 years. He founded the Graduate Group of Hydrologic Sciences in 1991 and currently serves as it Chair. He has general expertise in vadose zone hydrology and specific research and teaching experience in irrigation-drainage and soil salinity processes with well over 100 research publications in this area

- **Richard E. Howitt, Ph.D.** Dr. Howitt is a professor in the Department of Agricultural and Resource Economics at the University of California at Davis. Dr. Howitt has over 30 years of experience in area of agricultural economics, and has published approximately 100 articles, papers and books on this topic.

- **Harold L. Payne** Mr. Payne has over 20 years of professional experience providing technical support for water and land use studies, including data collection, review, interpretation, and evaluation of alternatives for water conservation technology, crop suitability, and soil management. Mr. Payne provides irrigation management, crop fertility management, farm production management, economic evaluations, farm cultural practices, and irrigation well water flow measurements for individual farmers, Indian tribes and corporations.

- **James D. Rhoades, Ph.D.** Dr. Rhoades is an expert in the field of agricultural science. Dr. Rhoades has nearly 40 years of experience assessing factors affecting crop irrigation needs, and has published more than 200 articles, papers and books on this subject.

- **John L. Scott** John L. Scott is an Engineer with employed by Metropolitan since 1991. During his tenure at Metropolitan, Mr. Scott has worked exclusively on Colorado River resource matters and the Salton Sea, a major portion of which has been dedicated to issues related to the Imperial Valley, including water use by IID.

- **Wynn R. Walker, Ph.D.** Dr. Walker is an expert in irrigation and water resources engineering, with specific expertise in surface irrigation system design, management and simulation. Dr. Walker has over 30 years experience with irrigation projects in the United States and in more than 20 foreign countries.

As discussed below, the analyses conducted by the Metropolitan Expert Team indicates that at most IID's current beneficial use needs justify only 2.568 MAF per year in total diversions from the Colorado River at the Imperial Dam. This estimate is conservative in allowing for tailwater runoff, leaching requirements and field non-uniformity. Moreover, this estimate does not account for conservation measures that already have been approved for implementation, such as lining of the All-American Canal, or for other conveyance system conservation measures that have been identified and studied. Indeed, when such measures are factored in, IID's beneficial use needs drop to 2.368 MAF per year in total diversions.

Metropolitan understands that it may not be practical for IID to reduce its diversions to 2.368 MAF in 2003. However, Metropolitan strongly believes that IID can and should be limited to no more than 2.81 MAF in total diversions at Imperial Dam for this year. This amount is based upon the average level of diversions that were occurring prior to 1994, when IID's usage dramatically and inexplicably increased by nearly 300,000 AF per year. It should be noted that this diversion amount reflects the reductions IID could achieve if it merely enforced its own restrictions on excessive tailwater.

Furthermore, as noted above, even this amount includes substantial volumes of waste. Accordingly, IID can and should be required to immediately begin implementing water monitoring and conservation activities, so as to reduce its usage of Colorado River water to 2.368 MAF per year within the next five years.

In short, as this submittal will demonstrate, the 3.10 MAF of Colorado River water requested by IID is clearly more than is needed and certainly more than is justified.

II. OVERVIEW OF APPLICABLE LEGAL STANDARDS

Evaluating the legitimacy of IID's request to divert 3.10 MAF of Colorado River water at Imperial Dam requires a clear understanding of the legal standards that serve as the foundation for the Part 417 process. While this subject has been addressed before, several points bear repeating.

First, no water contractor is entitled to receive more Colorado River water than it needs to satisfy reasonable beneficial uses. Stated another way, all Colorado River water must be put to uses that are both reasonable and beneficial. This requirement is set forth in the Colorado River Compact of 1922 ("1922 Compact")[2], the Boulder Canyon Project Act of 1928 ("BCPA")[3], the California Seven Party Agreement of 1931 ("Seven Party Agreement)[4], the BCPA Contract executed between IID and the United States in 1932 "(IID BCPA Contract")[5], and the Supreme Court's various decisions, decrees and

[2] See 1922 Compact art. III(a) (apportioning for "exclusive beneficial consumptive use" 7.5 MAF of Colorado River water to the Upper and Lower Basins); id. art. III(e) (prohibiting the Lower Basin states from requiring the "delivery of [Colorado River] water which cannot reasonably be applied to domestic and agricultural uses"); id. art. VIII (noting that present perfected rights "to beneficial use of [Colorado River] water" remained unimpaired by the 1922 Compact).

[3] See 43 U.S.C. § 617c(a) (stating that neither Arizona, California or Nevada "shall require the delivery of [Colorado River] water which cannot reasonably be applied to domestic and agricultural uses."). Other provisions of the BCPA incorporate the 1922 Compact and require compliance with its strictures by all users of Colorado River water, including the requirement of reasonable beneficial use. See 43 U.S.C. §§ 617g & 617l. Similarly, the BPCA incorporates the Reclamation Act of 1902 ("Reclamation Act"). See 43 U.S.C. § 617m. Section 8 of the Reclamation Act expressly states, "The right to the use of water acquired under the provisions of this Act shall be appurtenant to the land irrigated, and beneficial use shall be the basis, the measure, and the limit of the right." 43 U.S.C. § 372.

[4] See Seven Party Agreement § 3 (granting IID and the Palo Verde Irrigation District a third priority right to "beneficial consumptive use" of 3.85 MAF of Colorado River water).

[5] See IID BCPA Contract art. 17 (stating that water may be delivered to IID from storage in Hoover Dam "as reasonably required for potable and irrigation purposes"); see also id. art. 29 (noting that all rights under the IID BPCA Contract are "subject to and controlled by the

orders in the Arizona v. California case[6]. Unfortunately, as history has shown, this is a concept that IID cannot seem to grasp.

Second, the reasonable and beneficial use standard constitutes an overarching limitation that trumps all other considerations, including any water use priorities that may exist. The supremacy of this standard was recognized by the Supreme Court in its 1979 Order, in which it delineated the present perfected rights of various water users within California (including IID), Arizona and Nevada. As part of its order, the Court unequivocally stated, "Any water right listed herein may be exercised *only for beneficial uses*." Arizona v. California, 439 U.S. at 421 (emphasis added). Thus, contrary to what IID attempts to assert, the 3.85 MAF limit set forth in the Seven Party Agreement and its BPCA Contract constitutes a restriction on, rather than a right to, IID's unfettered use of Colorado River water. Furthermore, any right IID may have to use Colorado River comes with the corollary responsibility to use such water in a manner that is reasonable and beneficial, i.e., not wasteful.

Third, reasonable and beneficial use is a dynamic concept. It is measured based on the circumstances that exist at the time the water is being put to use. See United States v. Alpine Land & Reservoir Co. ("Alpine I") 697 F.2d 851, 855 (9th Cir. 1983) ("It is settled that beneficial use expresses a dynamic concept which is . . . 'variable according to conditions' and therefore over time.") (citations omitted); United States v. Alpine Land and Reservoir Company, ("Alpine II") 887 F.2d 207, 213 (9th Cir. 1989) (same); Environmental Defense Fund v. East Bay Municipal Utility District, 26 Cal. 3d 183, 194 (1980) ("What constitutes reasonable water use is dependent upon not only the entire circumstances presented but varies as the current situation changes."). Thus, a level or method of water use that was acceptable yesterday, may be wholly unacceptable today.

In this regard, supply and demand is one of the most important considerations in determining whether an existing or proposed use of water is reasonable and beneficial. As demand increases and supply decreases, a more stringent application of the reasonable beneficial use standard is not merely warranted, but required. As stated by the court in Tulare Irrigation District v. Lindsay-Strathmore Irrigation District:

> What is a beneficial use, of course, depends upon the facts and circumstances of each case. What may be a reasonable beneficial use, where water is present in excess of all needs, would not be a reasonable beneficial use in an area of great scarcity and great

Colorado River Compact"); id. art. 30 (noting that except as provided by the BCPA, the Reclamation Act governs operation of IID's All American Canal).

[6] See Arizona v. California, 376 U.S. 340, 343 (1964) [hereinafter "1964 Decree"] (stating that Colorado River water may be reallocated to another State if water users "cannot apply all of such water to beneficial uses."); Arizona v. California, 439 U.S. 419, 421(1979) [hereinafter "1979 Order"] (stating that any present perfected rights to Colorado River water "may be exercised only for beneficial uses").

> need. What is a beneficial use at one time may, because of changed conditions, become a waste at a later time.

3 Cal. 2d 489, 567 (1935); see also Alpine I, 697 F.2d at 854 (stating that "alternative uses of the water" must be considered in determining whether any particular use is unreasonable).

Nowhere is this more true than here. Southern California and, indeed, all of the Colorado River basin states are facing severe water shortages due to an increasing demand and a decreasing supply. We simply cannot allow anyone to waste Colorado River water (not even IID). Burley Irrigation District v. Ickes, 116 F.2d 529, 535 (D.C. Cir. 1940) ("Shortage makes the elimination of waste imperative."). Moreover, as discussed in Section IV.C. below, there have been remarkable advances in irrigation technology and management that render IID's current irrigation practices not only outmoded, but also unconscionable.[7] In short, IID's simplistic view of "first in time, first in right" is not defensible.

III. REVIEW OF PART 417 ASSESSMENT CRITERIA

A. Key Factors and Basic Principles

Part 417 sets forth certain factors DOI/BOR must consider in making determinations and recommendations concerning diversion and use of Colorado River water. These factors include:

1. the area to be irrigated;
2. climatic conditions;
3. location;
4. land classifications;
5. the kinds of crops raised;
6. cropping practices;
7. the type of irrigation system in use;
8. the conditions of water carriage and distribution facilities;
9. record of water orders, and rejections of ordered water;
10. general operating practices;
11. the operating efficiencies and methods of irrigation of the water users;
12. amount and rate of return flows to the river;

[7] Indeed, some commentators have argued that the combination of insufficient water supply and more efficient technology lays the foundation for a finding of waste. See Steven J. Shupe, "Waste in Western Water Law: A Blueprint for Change," 61 Or. L. Rev. 483, 492 (1982).

13. municipal water requirements; and,

14. the pertinent provisions of the Contractor's Boulder Canyon Project Act water delivery contract.

See 43 C.F.R. § 417.3.

The Part 417 regulations do not identify any particular approach or methodology that must be used in applying the factors discussed above. Rather, consistent with the legal authorities discussed in Section II, these regulations simply make clear that the purpose and objective in applying these factors is to ensure "that deliveries of Colorado River water to each Contractor will not exceed those reasonably required for beneficial use." Id. § 417.2.

Metropolitan therefore recognizes that there is no precise mathematical formula that DOI/BOR can apply to evaluate IID's request to divert 3.10 MAF of Colorado River water. Rather, DOI/BOR must make an informed and reasoned determination as to how much water IID can put to reasonable and beneficial use, based upon its review of the available technical data and information concerning IID's agricultural needs, operating procedures, and historical water use; its own knowledge of and familiarity with current irrigation and conservation technologies and practices; and its extensive experience in managing reclamation project water supplies and supervising irrigation district contractors.

That said, there are some basic principles that must guide any assessment of IID's diversion request. First, the concept of reasonable beneficial use necessarily excludes any allowance for waste. See, e.g., Alpine I, 697 F.2d at 854 ("There are two qualifications to what might be termed the general rule that water is beneficially used . . . when it is usefully employed by the appropriator. First, the use cannot include any element of 'waste' which, among other things, precludes unreasonable transmission losses and use of cost-ineffective methods."). As DOI/BOR is aware, the State Water Resources Control Board ("SWRCB") previously determined that IID's irrigation practices were wasteful. See In re Alleged Waste and Unreasonable Use of Water By Imperial District, SWRCB Decision 1600 (June 21, 1984) [hereinafter "Decision 1600"]. That determination compels close scrutiny of IID's current request to divert 3.10 MAF of Colorado River water at Imperial Dam.

Second, the fact that use of additional water will produce some marginal benefit is not enough to make that use "reasonable." See Vineyard Land & Stock Co. v. Twin Falls Oakley Land & Water Co., 245 F. 9, 24 (9th Cir. 1917) (upholding denial of appropriator's claim to additional water, where such water could not be economically applied); Alpine I, 697 F.2d at 854 (citing Vineyard Land & Stock Co. and stating, "[A]lthough application of additional water over the water duty awarded by the district court would provide some benefit to the appropriator, we upheld the district court's water duty because the gain was so small . . . that the additional increment of water would not be 'economically applied.'"). As discussed in Section IV.A., allowing IID to divert 2.368 MAF per year from the Colorado River at the Imperial Dam is more than sufficient to meet its beneficial use needs. Moreover, higher diversions would not provide any additional benefits in terms of meeting crop needs or increasing crop yields.

Third, it is clear that reasonable beneficial use requires the application of careful irrigation management practices. See Alpine I, 697 F.2d at 854 (citing "water duty" as the major conceptual tool for implementing beneficial use and defining it as "that measure of water, which, by careful management and use, without wastage, is reasonably required"); Burley Irrigation District, 116 F.2d at 535 (stating that "every reasonable measure of conservation is required" when water is scarce); Pyramid Lake Paiute Tribe of Indians v. Morton, 354 F. Supp. 252, 257 (D.D.C. 1972); (noting that "better management . . would prevent unnecessary waste"). Therefore, IID's water needs must be assessed based on what its irrigation management practices should be in the future, rather than on what they have been in the past.

Fourth, a water user can be required to adopt conservation measures and increase the efficiency of its water use, even if doing so will increase its costs. As explained by the SWRCB:

> The fact that water conservation may require the water user to incur additional expense provides no justification to continue wasteful or unreasonable practices. In People ex rel. State Water Resources Control Board v. Forni, 54 Cal.App.3d 743, 126 Cal.Rptr. 851 (1976), the court ruled that water users may properly be required to "endure some inconvenience or to incur reasonable expenses" in order to comply with the constitutional standard of putting the water resources of the state to maximum beneficial use.

Decision 1600 at 27.

In this case, IID often has asserted that if its water order is reduced, farmers within the district will be faced with the Hobson-esque choice of implementing costly conservation measures or fallowing land, either of which will result in severe economic hardship for the Imperial Valley. Yet, as discussed in Section IV.C., implementation of conservation measures is not only economically feasible, its economically beneficial. Indeed, the return on investment is almost immediate. But even if this were not the case, IID has no basis to complain. The fact remains that IID has been and still is receiving more water than it needs to satisfy reasonable beneficial uses. That constitutes waste and it must be eliminated – period.

Fifth and finally, the ability of one person to reuse or reclaim water that another discards is important in assessing the latter's reasonable beneficial use. A lower level of irrigation efficiency and, in turn, a higher level of irrigation runoff can be tolerated where that runoff is returned to the system. IID attempts to obfuscate this point, because it knows that its service area represents the end of the line for Colorado River water. Like it or not, once the water leaves IID's fields, all further opportunities for that water to be beneficially used are lost. See Vineyard Land & Stock Co., 245 F. at 28 (explaining that location of proposed use was crucial, because in one location the water would flow back into the river and be available for reuse by others, whereas in other locations it would not); United States v. Alpine Land & Reservoir Co., 503 F. Supp. 877, 890 (D. Nev. 1980), modified on other grounds, 697 F.2d 851 (9th Cir.) ("[E]ven where a relatively high water duty is assigned, other water users are not injured because the water not consumed all flows either back into the river or onto the water rights lands of another appropriator."); Decision 1600 at 25-26 ("[I]f virtually all of an irrigator's tailwater reenters the stream where it is available for downstream use, and if the diversion has no adverse effect on instream uses, then it may not be unreasonable to allow large quantities of tailwater.").

B. Ancillary Issues

One factor that is neither listed in Part 417 nor embodied within the legal meaning of reasonable beneficial use is the potential beneficial effect resulting from excess water flowing into environmentally sensitive areas. Nonetheless, IID and others have suggested that DOI/BOR should consider drainage flows from IID into the Salton Sea to be a beneficial use, because it ostensibly is helping to attenuate the salinity of this water body. There are two flaws with this argument.

First, even if such drainage is providing some "environmental benefit," it cannot not be considered a "beneficial use" of Colorado River water within the legal meaning of that term. The 1922 Compact, BCPA, BCPA Contract and 1964 Decree all make clear that Colorado River water can be beneficially used only for domestic and agricultural purposes and power generation. See 1922 Compact arts. II(h), III(e); BPCA, 43 U.S.C. §§ 617d, 617g; IID BPCA Contract art. 29; Arizona v. California, 376 U.S. at 341. Likewise, the 1979 Order specifically limits IID's present perfected rights to "the quantity of mainstream water necessary to supply consumptive use required for irrigation of 424,145 acres and for the satisfaction of *related uses* . . ." Arizona v. California, 439 U.S. at 429 (emphasis added). Clearly, drainage from IID to the Salton Sea cannot be considered to be a "related use."

Second, while the issue of increasing salinity in the Salton Sea is an important one that deserves careful consideration, this is not the proper forum to address that issue. Ensuring the continued viability of this water body is a complex problem that cannot be solved via annual water order determinations issued by DOI/BOR to individual contractors pursuant to Part 417. Nor was this problem ever intended to be solved via the Part 417 process. Instead, Congress has set up an entirely separate regulatory process for addressing environmental issues at the Salton Sea: the Salton Sea Reclamation Act of 1998 ("SSRA"). Among other things, the SSRA requires that:

> The Secretary [of the Interior] shall complete all studies, including, but not limited to environmental and other reviews, of the feasibility and benefit-cost of various options that permit the continued use of the Salton Sea as a reservoir for irrigation drainage and: (i) reduce and stabilize the overall salinity of the Salton Sea; (ii) stabilize the surface elevation of the Salton Sea; (iii) reclaim, in the long term, healthy fish and wildlife resources

> and their habitats; and (iv) enhance the potential for recreational uses and economic development of the Salton Sea.

P.L. 105-372 § 101(b)(a)(1) (1998).

In crafting the SSRA, Congress acknowledged that, "The Salton Sea itself has *no right or priority to receive water* from any source. Drainage and seepage waters that sustain the Sea are simply the *incidental result* of beneficial uses of water which are governed by existing laws, including the Law of the River." H.R. Rep. No. 105-621, 12 (emphasis added). Furthermore, Congress made it clear the SSRA was not intended "to supersede or otherwise affect any treaty, law, decree, contract, or agreement governing use of water from the Colorado River." Rather, "[a]ll activities taken under this Act must be carried out in a manner consistent with rights and obligations of persons under those treaties, laws, decrees, contracts, and agreements." P.L. 105-372 § 101(c).

In short, to the extent environmental issues exist at the Salton Sea, they must be addressed in the context of some other proceeding. See also Pyramid Lake, 354 F. Supp. at 252 (acknowledging that DOI/BOR was obligated to deliver enough water from the Truckee River to satisfy the water rights and legal entitlements for the Newlands Project in Nevada first, before allowing any excess water to flow into Pyramid Lake); 97 Interior Decision 32, 37-38 (noting that the Operating Criteria and Procedures ("OCAP") adopted by DOI/BOR for the Newlands Project in response to the court's decision in Pyramid Lake would result in adverse impacts to the Stillwater refuge, but noting that the refuge "has no right to rely on the continued availability of waste water from the Project.")[8]

Apart from the Salton Sea issue, there are a number of other red herrings that IID has released in the hope that DOI/BOR will chase them as part of this proceeding. For example, IID has argued that DOI/BOR should apply state law in evaluating IID's request to divert 3.10 MAF of Colorado River water, implying that the result would somehow be different. Yet, California law also requires that water be used in a reasonable and beneficial manner. See, e.g., Cal. Const. art. X, § 2 ("[T]he general welfare requires that the water resources of the State be put to beneficial use to the fullest extent to which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented . . . ."). Indeed, the whole purpose of this Part 417 proceeding is determine what IID's reasonable beneficial use needs are. Thus, contrary to what IID asserts, this proceeding does not pose any conflict with state law.

[8] More specifically, DOI's solicitor stated: "One direct consequence of the [OCAP] however, will be to reduce drainage of excess irrigation water to Stillwater. Absent another source of water for Stillwater, this reduced drainage will result in a loss of wetlands, and an attendant drop in wildlife areas. The OCAP do not attempt to mitigate this impact because the area possesses no primary water rights for wildlife use. Instead, Stillwater receives Project runoff under an appropriative right and uses the water for wildlife purposes. Nev. State Eng. Permits Nos. 13345-51 (Oct. 26, 1987). Therefore, Stillwater has no right to rely on the continued availability of waste water from the Project. Bowers v. Big Horn Canal Ass'n, 77 Wyo. 80, 307 P.2d 593 (1957)."

IID also has argued that DOI/BOR should look to "local custom" in evaluating its water needs. However, under California law, local custom is only one factor to be considered in assessing reasonable beneficial use, and it is subordinate to other considerations. See Cal. Water Code § 100.5 ("It is hereby declared to be the established policy of this state that conformity of a use, method of use, or method of diversion of water with local custom shall not be solely determinative of its reasonableness . . . ."); Tulare Irrigation District, 3 Cal. 2d at 547 ("[An appropriator] is entitled to make a reasonable use of the water according to the general custom of the locality, so long as the custom does not involve unnecessary waste."); Erickson v. Queen Valley Ranch Company, 22 Cal. App. 3d 578, 584-585 (1971) (use of inefficient irrigation ditches was wasteful and not a reasonable use despite the fact that use of such ditches was the local custom); Decision 1600 at 28 ("[C]onformity with local custom alone does not foreclose a finding of waste and unreasonable use.").

Lastly, IID has argued that DOI/BOR "must undertake a new Part 417 beneficial use analysis of not only IID's water use for 2003, but for every other California contract holder as well." See Letter from David Osias to Gale Norton and Steven Macfarlane, United States Department of Interior (Apr. 25, 2003) [hereinafter "Osias Letter"], p. 3. Presumably, this would include a review of water requirements for the Palo Verde Irrigation District (PVID), Bard Water District, Coachella Valley Water District (CVWD), Metropolitan and the City of Needles. According to the Osias Letter, this wholesale review is needed because "the 2003 Colorado River water use of every California agency is interdependent on the use by others." Id. As with IID's other arguments, this one has no merit.

First, DOI/BOR already has reviewed the beneficial use needs and water requirements of other California water contractors for 2003. None of those Part 417 determinations were challenged by IID or anyone else, either administratively or as part of the IID Litigation. Nor did the district court's remand order direct a *de novo* review of water requirements for contractors other than IID. Consequently, a wholesale review of the beneficial use needs water requirements of "every other California contract holder" is completely beyond the scope of this proceeding.[9]

Second, there is no general requirement that when a governmental agency examines one person's water use, it must examine everyone else's water use at the same time. For example, when the SWRCB investigated IID's use of Colorado River water in the 1980s, it did not feel compelled to conduct a contemporaneous evaluation of every other contractor's water use. See generally Decision 1600. Indeed, there is no administrative precedent or analogy for the type of proceeding IID is suggesting should be conducted by DOI/BOR. Rather, the Part 417 regulations contemplate individualized

[9] Indeed, if DOI/BOR were to conduct such a review as part of this proceeding, it would raise serious procedural problems under the Administrative Procedures Act ("APA"), 5 U.S.C §§ 501 et. seq. The *Federal Register* notice solicited information, comments and suggestions solely concerning IID's estimated water requirements for 2003. See 68 Fed. Reg. at 22738. Accordingly, there would be a serious APA notice defect if this proceeding were converted into a broad review of the beneficial use needs and water requirements of contractors other than IID.

determinations for each contractor, rather than one grand consolidated review of all beneficial use within California.

Third, it is true that one contractor's use of the Colorado River can seriously affect another's and, to that extent, all of the California contractors are indeed "interdependent." Clearly, if that were not the case, Metropolitan would have no reason to be involved in this proceeding. But such interdependence in no way undermines DOI/BOR's ability to conduct an immediate review of IID water requirements, nor does it obviate the need to do so. DOI/BOR already knows that the demand for Colorado River water far exceeds the supply. Accordingly, if IID is diverting more Colorado River water than it needs to satisfy reasonable beneficial uses, that diversion should be reduced now.[10]

Conducting a simultaneous, full-scale review of every California contractor's beneficial use needs and water requirements would not make this Part 417 process any fairer, only slower – much slower. A case in point is the SWRCB's investigation of IID's waste of water in 1980s. It took four years from the date the complaint was filed for the SWRCB to render its decision in which concluded that IID was wasting Colorado River. See Decision 1600 at 2. And that proceeding focused solely on IID. Expanding the current Part 417 proceeding to include a review of every other contractor's water requirements would not make the process merely unwieldy, it would make it entirely unworkable.[11]

In sum, DOI/BOR cannot and should not allow this process to get sidetracked by focusing on issues have no bearing on the question before us: Can IID can put 3.10 MAF to "reasonable and beneficial" use within the legal meaning of those terms? As discussed in detail below, the resounding answer to that question is "No."

IV. ANALYSIS OF IID'S WATER REQUIREMENTS

As noted, the Part 417 regulations do not specify any particular methodology that must be used in applying the factors listed above. However, for purposes of this discussion, these factors can be and have been divided into one of three groups: (1) factors relating to IID's current needs for Colorado River water; (2) factors relating to IID's historical usage of Colorado River water; and (3) factors relating to IID's future ability to conserve Colorado River water.

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10 Of course, this in no way precludes or hinders DOI/BOR in re-examining others' beneficial use needs in separate proceedings.

11 Obviously, IID has an interest in making this Part 417 proceeding move as slowly as possible, since doing so allows it to continue wasting Colorado River water.

A. Current Water Needs

1. Overview of Technical Approach

Questions concerning IID's current water use, and whether that use is in excess of its needs, are easily answered with the appropriate data. However, according to IID, farm-level data concerning the delivery, use and management of Colorado River water within the district are not available. Ironically, it is IID that consistently has thwarted efforts to collect the very data that could easily explain its water use and, in turn, its water needs.[12]

In the absence of such farm-level data, numerous studies have been conducted over the years in an effort to characterize and quantify water use within IID. IID itself has conducted several of these studies in an attempt to justify its historic use. Unfortunately, the limited data and questionable methods used in the various IID studies, seriously undermine their credibility and usefulness. For example, in March 2002, IID commissioned a study by Natural Resources Consulting Engineers ("NRCE"), which tried to explain water use within the entire IID service area by extrapolating from data collected during a few summertime irrigation events on a handful of carefully selected fields. See Natural Resources Consulting Engineers, Assessment of Imperial Irrigation District's Water Use (March 2002) [hereinafter "NRCE Report"].

More recently, IID's economic consultant, Dr. Rodney Smith, has tried to explain water use with economic theory and variables so inappropriately chosen that one might as well correlate growth in water use in Imperial Valley to growth in SUV ownership. (See Howitt, R.E. and S. Msangi (2003) at Tab 8.) These studies and others are contrary to accepted scientific technique, which dictates a ground up approach to establish on-farm water needs based on sound science and proven methods. This approach focuses on what IID's actual water needs are, rather than on what its usage has been.

Accordingly, Dr. Rhoades, made a number of assessments to estimate the on-farm water use requirements within IID and to estimate the volumes of water wasted within IID. In cooperation with other Metropolitan Expert Team members, Dr. Rhoades calculated an "on-farm water budget" for IID using some of the technical criteria described in the Part 417 regulations. Such a "water budget" or "water balance" is a standard, well-accepted technique used to determine water use requirements for agricultural production. Simply defined, a "water balance" is an accounting of water entering and leaving a three dimensional space over a particular time interval using water categories or "fractions" appropriate to agronomic production.[13] The term "balance" is

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[12] For example, in 1982-83 IID participated with DOI/BOR in a joint irrigation water management (scheduling) program to reduce tailwater flows. However, after collection of data and concluding the field support and report, IID withdrew from the program.

[13] See Charles M. Burt, "Irrigation Water Balance Fundamentals," Irrigation Training and Research Center Paper 99-001 (1999), p.1 [hereinafter "Irrigation Fundamentals"], *available at* www.itrc.org/papers/IrrWaterBal/IrrWaterBal.pdf.

based on the conservation of mass principle that the amount of water entering a particular space and the amount of water leaving that particular space should "balance" after adjusting for any change in internal storage in the spatial area being investigated. (See Rhoades, J.D. (2003a) & Rhoades (2003c) at Tab 1.)

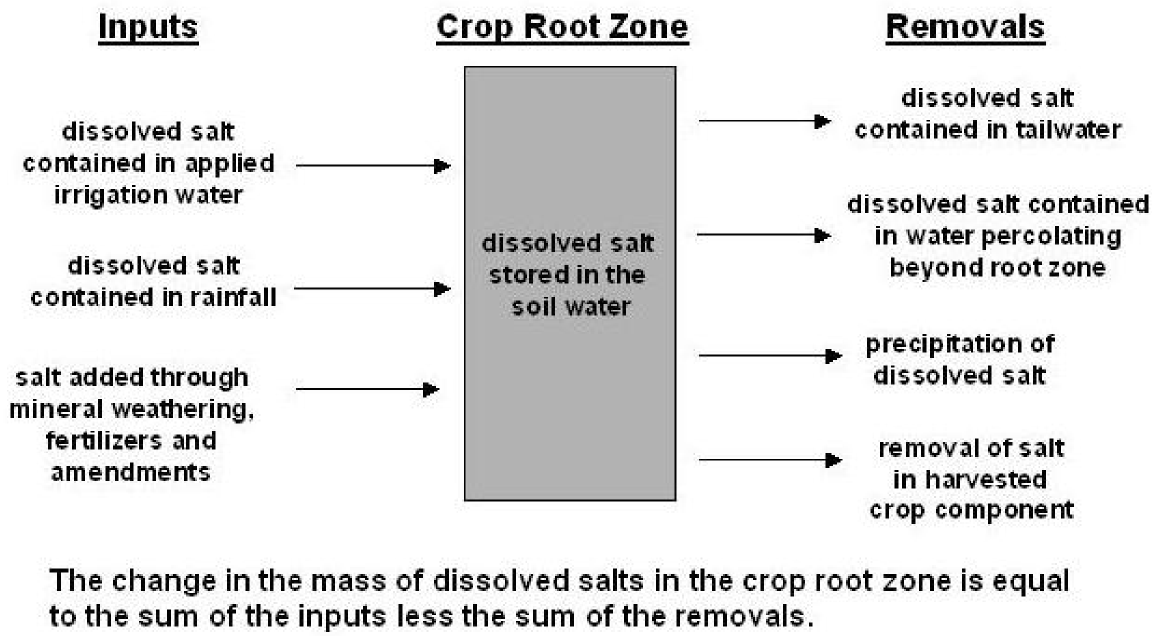
In addition, Dr. Rhoades used the scientific principles of constituent mass balance to separately and independently calculate the additional volumes of water that drain from farms within IID and are lost to further use. (This drainage is referred to as "tailwater" and "tilewater" by IID: the former is the excess surface water that drains off the tail ends of the fields whereas the latter is subsurface drainage collected, for the most part, via underground tile drain lines.) (See Rhoades, J.D. (2003b) at Tab 1.)

2. On-Farm Irrigation Needs

To calculate on-farm irrigation needs, Dr Rhoades used an on-farm water and salinity budget analysis, a commonly used methodology to determine the amount of water necessary to sustain full yields for particular crops under various conditions. The on-farm water budget analysis recognizes that to sustain full yields, the inflows and outflows of both water and salts, with reference to the root zone of a particular crop, must keep the salt concentration in the soil water from becoming excessive for sustained plant growth. The analysis consists of determining the gain or loss in soil water and salinity content and concentration that occurs as a result of various inputs and outputs of water and salt, with reference to the crop rootzone.

Figure 1 depicts the on-farm water budget methodology. As noted above, the analysis consists of determining the gain or loss in soil water and salinity content that occurs as a result of various inputs and outputs of water and salt, with reference to the crop rootzone. For this analysis, inputs to the crop rootzone include i) the volume of applied irrigation water and the dissolved salt contained in that water, ii) the volume of rainfall and the dissolved salt contained in that rainfall, and iii) salts added through mineral weathering, fertilizers, and amendments. Outputs include the i) volume of water consumed by the crop through plant transpiration and evaporation from the soil (commonly referred to as crop evapotranspiration, or "crop ET"), ii) the volume of water percolating below the rootzone and the soluble salt removed from the soil by this deep percolation, iii) the volume of "tailwater" that flows over the surface of the soil and away from the system, iv) the amount of salt removed from solution within the crop rootzone by mineral precipitation, and v) the amount of salt contained in the harvested part of the crop that is removed from the field.

Figure 1
Salt and Water Budget



Although conceptually simple, the on-farm water balance approach requires detailed calculations and analysis to estimate the various inputs and outputs. While some inputs and outputs are relatively straightforward and easy to measure or accurately estimate, such as rainfall, others are not. One such area is the amount of “leaching” that is required to keep the absolute salt concentration within the active crop rootzone from becoming too excessive to sustain plant growth. Associated with this area is a determination of the relative amount of leaching which is accomplished through “vertical leaching,” in which salts are carried out of the rootzone through deep percolation, versus the amount which is accomplished through “horizontal leaching,” in which the surface water dissolves some salt from the soil as it flows over the ground and carries it off in the tailwater. Also discussed below is the use of a special adjustment factor to account for the non-uniform conditions encountered in real-world irrigation practice.

a) Water Required For Leaching

To sustain full crop yields, water is required to leach salts from the soil to maintain soil salinity at the crop rootzone within acceptable limits. This amount of water is expressed as the “leaching requirement,” which is the fraction of the infiltrated irrigation water required for soil salinity control. Dr. Rhoades estimated the leaching requirement for the IID service area using a sophisticated steady-state model known as WATSUIT. The WATSUIT model accounts for the removal of salts added to the soil by the infiltration of irrigation water as a result of salt precipitation within the crop rootzone. The WATSUIT model has been tested under various conditions and found to provide good predictions with results very similar to more exact but less practical transient models.

The leaching requirement for the IID service area was estimated for year 2003 conditions, taking into account the salinity composition and concentration of the Colorado River irrigation water, the mixture of crops grown in the IID and their consumptive-use requirements based on recent 2000-2002 data and available standard crop salt-tolerance data. This leaching requirement value represents the overall "consumptive-use and leaching requirement" weighted district-wide for the mixture of all crops estimated to be grown in the IID service area.

The crop ET data that Dr. Rhoades used in his calculations were those computed for the 1997 to 2002 period by Dr. Richard G. Allen, also a member Metropolitan's Expert Team. As explained in detail by Dr. Allen (see Allen, R.G. (2003a, 2003b) at Tab 2), the estimate of the mean net crop ET requirement of Colorado River water for this period of about 1,705,000 acre-feet is likely to be far more accurate than the available estimates by other entities.

Because the current leaching requirement is affected by the salinity of the irrigation water supply, recent Colorado River water quality data (years 2000 to 2002) were used. The average Colorado River salinity for the period 2000 to 2002, and predicted for 2003, is 1.091 decisiemens per meter (dS/m). Colorado River salinity has been trending down, and this value is lower than it was during the 1989 to 1996 period, when it averaged 1.213 dS/m.

With these and other inputs, the IID-wide weighted leaching requirement value was calculated with the WATSUIT model by Dr. Rhoades as 0.060, or 6 percent of the volume of water that infiltrates the soil. That is, 6 percent of the volume of infiltrated water must pass through the rootzone and emerge as deep percolation, or as "tilewater," in order to leach salts from the rootzone and maintain productive soil chemistry.[14] This value was based on the weighted salt-tolerances, cropped acreages and consumptive use of each crop produced in the IID during the period 2000-2002.

For comparison, Dr. Rhoades also estimated the leaching requirement using the so-called Traditional model which does not account for salt precipitation and thus provides a higher result. However, the values from this model are considered to be far less accurate than those obtained using the WATSUIT model.

Dr. Rhoades conducted a literature search indicating the leaching requirement values estimated by others to be occurring in IID fields ranged from about 6 percent to about 10 percent. That Dr. Rhoades' estimate falls within the low end of this range is to be expected given that Colorado River salinity is currently lower than it has been in the past and Dr. Rhoades' use of the more accurate, but less conservative WATSUIT model.

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[14] Not all of the deep percolation is collected by the tile drainage system underlying a given field, but the term tilewater as used by the IID assumes the two terms ("tile water" and "deep percolation") are synonymous.

b) The Effect of Tailwater In Soil Salinity Control

IID admits that substantial volumes of irrigation water drain off fields in its service area as tailwater and are lost to further use. Recently, IID estimated this volume at 426,000 acre-feet per year. (NRCE 2002.) While Metropolitan's technical experts believe the number is far greater, there is no dispute that tailwater accounts for a large portion of IID's Colorado River water order.

IID justifies part of the huge tailwater flows as necessary for the control of soil salinity, in a process IID's consultants term "horizontal leaching." Dr. Rhoades evaluated this claim by developing relationships to account for the effect of horizontal leaching in his determination of the leaching requirement. In doing so, he was able to quantify the actual beneficial effects of tailwater in soil salinity control.

Dr. Rhoades has shown that with tailwater flowing at 15 percent of the deliveries to the head of the field (the maximum amount allowed per IID's current regulations), the district-wide leaching requirement is reduced from about 0.058 to only about 0.056 by the effect of horizontal leaching. Translated in terms of percentages, this means that only about 1 percent of the tailwater volume contributes beneficially with the same effectiveness as deep percolation. In terms of amounts, the corresponding district-wide volume of tailwater that contributes to salinity control is only 3,700 acre-feet. These benefits, as small as they are at 15 percent tailwater, are even less at lower tailwater volumes. Thus, in comparison to the effectiveness of deep percolation in supplying the required leaching for IID fields and in comparison to the total leaching requirement, the impact and benefit of salt removal by tailwater is insignificant. Even though the horizontal leaching benefit is effectively nil, Dr. Rhoades nonetheless included its effect in all of his water needs assessments.

c) Allowance for Irrigation Inefficiencies

If the irrigation water could be applied completely uniformly to a uniform soil and uniform crop, only a volume of irrigation water equivalent to the potential crop consumptive use plus the required leaching would needed. But often with surface irrigation systems, non-uniformity of irrigation results in excess irrigation water being infiltrated toward the upper-end of the field and an insufficient amount of water being infiltrated toward the lower end of the field. In such typical cases of non-uniformity of application and infiltration, the actual volume of water utilized in crop ET is usually slightly less than the theoretical maximum-potential crop ET, and the actual volume of deep percolation effectively used in leaching is usually less than that theoretically required.

But to compensate for irrigation inefficiencies and minimize any negative effects on crop yields, growers sometimes intentionally apply more water than what is theoretically and actually needed. However, if the additional water is not simply lost as increased tailwater waste, over application can lead to serious consequences including elevated water tables, water logging and insufficient aeration, scalding, and unnecessary burdens to the drainage requirement, both in terms of unnecessary increases in flows and increases in salinity from leaching out of more salt than is necessary.

To account for the effects of irrigation inefficiencies, Metropolitan's technical experts evaluated an allowance for extra irrigation water that would strike an appropriate balance between the positive effects of increased crop yields and the detrimental effects of over-irrigation. The scientific principles and data applied to determine appropriate inputs for non-uniformity of irrigation within IID are described by Metropolitan's Technical Experts Dr. Richard G. Allen (see Allen, R.G. (2003a, 2003b) at Tab 2) and Dr. Wynn Walker (see Walker, W.R. (2003a, 2003b, 2003c) at Tab 3). The expert team concluded that fields within the IID service area are very conducive to the achievement of uniform water infiltration and leaching because the cracking soils allow for a rapid filling of void space followed by a rapid decline in infiltration rate to very low levels. Thus, the need for additional water for irrigation non-uniformity and irrigation inefficiency is minimal for such soils. Nonetheless, an allowance for non-uniformity of irrigation equivalent to an extra 5 percent of the theoretically required water was factored into Rhoades' calculations of on-farm irrigation needs. This is in addition to the amount assumed for tailwater. According to Rhoades, the extra allowance he used in his assessments is liberal for tailwater percentages greater than about 10 percent and amounts to some degree of double accounting, all to the benefit of IID.

d) Calculation of On-Farm Needs and Resulting Diversion Amounts

Using the factors described above and other appropriate inputs, Dr. Rhoades determined the volume of irrigation water required to meet all on farm needs within IID for three varying levels of tailwater percentages: 15, 10, and 5 percent. The three levels of tailwater were selected by Metropolitan's team of experts to reflect IID's water requirement that can be achieved immediately by simply holding irrigators to a cap of 15 percent tailwater (per current IID regulations), as well as the water requirements given implementation of increasing levels of simple irrigation management practices to reduce tailwater waste.

For the 15 percent tailwater case, the volume of Colorado River water required for delivery to farms in IID to meet all irrigation requirements for 2003 year conditions (excluding duck ponds and fish farms) without any reduction in crop acreage or yield was determined by Dr. Rhoades to be about 2,238,000 acre-feet. This estimate includes all water needs to meet crop ET demands, the total leaching requirement (including consideration of horizontal leaching), the allowance for excess deep percolation to account for distribution inefficiencies, and tailwater. The tailwater volume in this case corresponds to 336,000 acre-feet. The farm delivery requirements for Colorado River water in IID to meet on-farm cropping needs are reduced to about 2,115,000 acre-feet and to about 2,005,000 acre-feet for the 10 percent and 5 percent tailwater conditions, respectively. The volumes of tailwater corresponding to the 10 and 5 percent tailwater conditions are 211,200 acre-feet and 100,000 acre-feet, respectively.

As explained by Dr. Rhoades (see Rhoades, J.D. (2003a, 20003b, 2003c) at Tab 1), these estimates for the 2003 IID on-farm water requirements are conservative for the following reasons:

1. Salt tolerance threshold values used in the analyses are conservative (on the low side) causing leaching requirement calculations to be conservatively high.

2. It is believed that most of the deep percolation in IID contributes to required leaching. This is because the IID-wide leaching fraction is low and so many of the soils have low permeability. For a typical irrigation of fine-textured soils, distribution of infiltration is high, and thus, deep percolation has high uniformity and can be credited towards fulfilling leaching requirements. Further, for typical irrigation on coarser-textured soils in IID, the relatively large amounts of incidental deep percolation likely flows to lower lying fields within IID, where some of it is subsequently consumed by deep-rooted crops. Thus, the low leaching requirement of IID is met by low amounts of relatively uniform deep percolation on fine-textured soils and by relatively larger amounts of less uniform deep percolation on coarse-textured soils that are subsequently partially recaptured and used elsewhere in the service area.

3. Multiple irrigations have higher uniformity of infiltration than do individual events. Many portions of a field that are under-irrigated during a single irrigation event tend to have higher than average infiltration rates for a subsequent irrigation event (because they are more cracked and drier). The resulting relatively higher infiltration rates encourage relatively greater infiltration depths for those areas during subsequent irrigation event(s), thereby resulting in more uniform infiltration across multiple events.

4. Many fields in IID are prone to having a shallow water table develop during parts of the growing season and following large irrigation events. This shallow water can supply a portion of the ET requirement of medium and deep-rooted crops. Therefore, some of the deep percolation losses computed by simulation models or as observed during field studies actually contribute beneficially to the overall ET requirement.

5. Because the soil profile has large capacity to accumulate salts, some build up of salts during irrigation events having low amounts of leaching can be tolerated over the short term, for example, over a single growing season. The required leaching is subsequently provided during pre-plant and early season irrigations.

6. The leaching fraction achieved is actually higher than that corresponding to the leaching requirement determined by Dr. Rhoades' analysis

because of the extra water given for compensation of irrigation inefficiencies.

7. Salt balance assessments based on salt concentrations of tilewater drainage and isotopic analyses of percolation rates in the IID strongly support the conclusion that there are physical limits on movement of water vertically through soil profiles of IID on a district-wide basis. That is, Dr. Rhoades' estimates, with the inclusion of the extra water for compensation for non-uniformity and tailwater probably represent about as much water as can effectively be infiltrated into the soils on a district-wide average.

8. The relative "tightness" of heavy soils in IID, following the filling of cracks by water during irrigation, tends to beneficially increase uniformity of irrigation.

The volumes of Colorado River water required for diversion into IID, including the on-farm irrigation requirements described above, are given in Table 1. Also given in this table are the additional volumes of Colorado River water required for duck ponds, fish-farms, miscellaneous deliveries and conveyance/distribution losses upstream of the farm headgate, resulting in the net (or "consumptive use") diversion requirement. Adjustment for estimated return flow credit gives the corresponding estimates of IID's total diversion requirement of Colorado River water for each of the tailwater cases considered, shown in comparison to the Revised Water Order.

The differences between the Revised Water Order volume of 3.10 MAF and those for the three estimates provided equals the volumes of tailwater loss that would be conserved for the three tailwater conditions. In terms of reduced diversions, these volumes are 291,317 (15 percent tailwater), 417,909 (10 percent tailwater) and 531,445 (5 percent tailwater) acre-feet. The total diversion volumes reported in Table 1 do not account for identified and available system conservation measures slated for implementation in the near future.

Table 1
Current On-Farm Water Requirements and Resulting IID Diversions
(values in acre-feet)

Tailwater Condition	On-Farm Water Requirements: Crop ET	Deep Percolation	Tailwater	Delivered to Farm	Net (CU) Diversion [2]	Estimated Return Flow Credit	Total Diversion [3]
Revised Water Order [1]	1,705,289	196,647	617,253	2,519,189	3,003,200	96,800	3,100,000
15 percent Tailwater	1,705,289	196,647	335,636	2,237,572	2,721,583	87,100	2,808,683
10 percent Tailwater	1,705,289	198,103	211,488	2,114,880	2,598,891	83,200	2,682,091
5 percent Tailwater	1,705,289	199,408	100,247	2,004,944	2,488,955	79,600	2,568,555

[1] Assumes the increased net diversion requirement from the 15 percent tailwater condition to the Revised Water Order condition would be entirely due to additional tailwater volumes.
[2] Net (consumptive use) diversion requirement based on 484,011 acre-feet of miscellaneous deliveries and conveyance losses upstream of the farm headgate, as reported in by Scott (see Scott, J. (2003b) at Tab 4).
[3] Total diversion requirement is equal to the net diversion requirement plus DOI/BOR's estimated return flow credit which, as set forth in the Raley Letter, equals 3.2% of the net diversions.

3. Estimates of Tailwater and Deep Percolation

Losses of water occur from farms within the IID in the form of tailwater and as excess, but limited, deep percolation. Deep percolation is required for the control of soil salinity; whereas, as Dr. Rhoades has established, tailwater contributes only a very minor, insignificant benefit to salinity control. Additional losses of water occur in the IID service area by spillage and by seepage from the delivery canals.

A lack of available tailwater and drainage flow data has hampered efforts to definitively quantify the volume of tailwater occurring within IID.[15] However, several water balance studies have been conducted since the early 1980s by IID and its consultants, and by DOI/BOR and its consultants in an attempt to quantify – or conceal – the actual volumes of tailwater waste draining from farms served by IID. The greatest interest, controversy, and uncertainty involve the relative proportion and volumes of tailwater and deep percolation.

To remove this uncertainty, Dr. Rhoades used several different methodologies to estimate tailwater and deep percolation: a water balance method, a constituent mass balance method for drainage at the IID service area level, and a constituent mass balance

[15] In Decision 1600, the State Water Resources Control Board (SWRCB) found that there was insufficient tailwater monitoring data available to estimate the volume of tailwater draining off farms served by the Imperial Irrigation District (IID).

method at the root zone level. Additionally for the constituent mass balance method at the root zone, Rhoades used two different analytical approaches. Each independent approach yielded similar estimates of tailwater and deep percolation.

a) Water Balance Method

The ability to acquire reliable data for different components or fractions in a water balance may vary. Consequently, water balances typically have a "closure term," meaning that because of difficulties in directly measuring values for a component in a water balance, the values for those component are estimated or extrapolated from other better-known components in the water balance, i.e. the balance "closes" on the term for which direct measurement is more difficult.[16]

As previously noted, because of the low permeability of IID soils, Dr. Rhoades' estimates of IID's water requirements, with the inclusion of the extra water for compensation for non-uniformity, probably represent about as much water as can effectively be infiltrated on a district-wide average. Thus, because deep percolation is physically limited to the amount required for leaching plus the additional allowance for distribution non-uniformity, Dr. Rhoades derived this volume directly from his water requirements calculations.

Based on the calculated required volume of Colorado River water for on-farm irrigation, Dr. Rhoades then "closed" on the tailwater term. That is, he estimated tailwater by subtracting the total on-farm requirement from IID's water deliveries, after adjusting for the conveyance and distribution system losses, miscellaneous deliveries, and return flows as shown in Table 1. Using this approach, with IID's Revised Water Order of 3.10 MAF in total deliveries for 2003, Dr. Rhoades estimated that tailwater presently accounts for 617,000 acre-feet, or about 24.5 percent of farm deliveries. Deep percolation, as Dr. Rhoades calculated using WATSUIT, accounts for about 196,600 acre-feet.

b) Constituent Mass Balance Methods

A chloride mass balance analysis is different from the water balance approach historically used to estimate tailwater in IID (and which Dr. Rhoades also used) in that it does not depend on the prior estimate of tailwater volume in order to obtain a deep percolation volume by closure, or vice-versa.

One of the mass balance approaches used by in Dr. Rhoades was based on a published approach (Setmire *et al*. (1993) and Setmire *et al*. (1996)) for estimating the contribution of subsurface drainage to the Alamo River. This "Setmire" approach utilizes the chloride concentration data of (i) subsurface drainage based on water samples collected from tile drains, (ii) irrigation supply water, based on samples collected from the East Highline Canal and the Colorado River above Imperial Dam, and (iii) blended

[16] Irrigation Fundamentals at 6-7.

surface and subsurface drainwater from samples collected from IID surface drains and the Alamo River.

Dr. Rhoades conducted his chloride mass balance estimates of tailwater using (i) a basin-wide "Setmire" approach and (ii) an on-farm "rootzone mass balance model" approach. In both of these independent approaches, Dr. Rhoades explored the effects of possible salt inputs to the IID drainage system that were not considered by the Setmire studies. Each independent approach yielded similar estimates of tailwater and deep percolation. Dr. Rhoades' best estimates of tailwater and deep percolation with the Setmire approach were 618,000 acre-feet and 186,000 acre-feet, respectively. With his rootzone mass balance model, his results were 668,000 acre-feet tailwater and 134,000 acre-feet deep percolation. Dr. Rhoades observed that the Setmire approach would underestimate the tailwater volume and overestimate the volume of deep percolation for certain saline groundwater conditions, whereas his rootzone mass balance model would underestimate the volume of deep percolation and overestimate the tailwater volume for those same conditions. Since these errors are opposite in effect, Dr. Rhoades averaged the two sets of results to arrive at his mass balance estimates of 637,400 acre-feet tailwater and 165,400 acre-feet deep percolation. Dr. Rhoades' average chloride balance determined tailwater volume (637,000 acre-feet) is within just 3 percent of the result (617,000 acre-feet) he independently calculated using water balance principles.

The salt balance assessments performed by Dr. Rhoades strongly support the belief that there are physical limits on movement of water through soil profiles of lands within IID on a district-wide basis. Dr. Rhoades has identified studies which support this belief, including a United States Geological Survey (USGS) study that indicates that the maximum amount of water that can be vertically percolated within the IID is about 135,000 acre-feet per year. Dr. Rhoades observes that this limited level of vertical drainage has not caused undue salinity problems over the long-term for the vast majority of the district, indicating that this physical constraint represents an advantage to irrigation efficiency.

c) Comparison With Other Estimates

Metropolitan compared Dr. Rhoades' estimates of tailwater and deep percolation against those volumes previously estimated by IID, its consultants, and other parties. Specifically, the water balances produced since the early 1980s and their estimates of tilewater and deep percolation as presented in the following studies and reports were reviewed and compared:

- <u>IID Litigation</u>, Imperial Irrigation District Exhibit 16, submitted December 12, 1983 [hereinafter "IID (1984)"].
- U.S. Bureau of Reclamation; July 1984; *Water Conservation Opportunities: Imperial Irrigation District, California* [hereinafter "USBR (1984)"].

- Parsons Water Resources, Inc.; 1985; *Water Requirements and Availability Study for Imperial Irrigation District* [hereinafter "Parsons (1985")].

- Imperial Irrigation District; 1993; *Draft Environmental Impact Report for Modified East Lowline and Trifolium Interceptors, and Completion Projects* [hereinafter "IID (1993)"].

- Boyle Engineering Corporation; August 1993; *On-farm Irrigation Efficiency: Special Technical Report for Imperial Irrigation District* [hereinafter "Boyle (1993)"].

- Imperial Irrigation District; May 1994; *Final Environmental Impact Report for Modified East Lowline and Trifolium Interceptors, and Completion Projects* [hereinafter "IID (1994)"].

- Imperial Irrigation District; January 2, 1996; *Draft Water Requirements and Availability Study* [hereinafter "IID (1996)"].

- Water Study Team (WST); March 1998; *Imperial Irrigation District Water Use Assessment For the Years 1987-1996*; prepared for the Imperial Irrigation District [hereinafter "WST (1998)"].

- Imperial Irrigation District; June 2002; *Imperial Irrigation District Water Conservation and Transfer Project Final Environmental Impact Report/Environmental Impact Statement* (State Clearinghouse No. 99091142) [hereinafter "IID (2002)"].

- Natural Resources Consulting Engineers, Inc.; March 2002; *Assessment of Imperial Irrigation District's Water Use* [hereinafter "NRCE (2002)"].

- Jensen, Marvin E., Walter, Ivan A.; November 2002; *Assessment Of 1997-2001 Water Use By The Imperial Irrigation District* (including errata sheet dated January 31, 2003) [hereinafter "Jensen (2002)"].

The methods for conducting these water balances can be grouped into three categories: 1) estimates based on presumed or tailwater volumes, with deep percolation as the closure term; 2) estimates based on direct estimation of tailwater or deep percolation, and 3) estimates based on presumed deep percolation, with tailwater as the closure term. None of the previous estimating methodologies used the constituent mass balance principles employed by Dr. Rhoades. These previous estimates are described by Mr. John Scott (see Scott, J. (2003d) at Tab 4) and summarized below.

Water Balances Prepared Prior To 1985

Water balances prepared for years prior to 1985 (USBR (1984), IID (1983), and Parsons (1985)) resulted in similar estimates of tailwater and deep percolation, with tailwater estimates ranging from 211,000 to 312,000 acre-feet per year and deep percolation estimates ranging from 236,000 to 281,000 acre-feet per year. These estimates were hampered by poor quality data concerning IID's operations. This resulted in significant uncertainty in the estimates regarding farm drainage volumes.

IID (1983) and Parsons (1985) water balances were unique in that while most of the methods presume a tailwater or deep percolation volume, these balances attempt to estimate deep percolation directly. These studies made use of available quantity and quality data on tilewater that was compiled from 1975 to 1982 to develop an estimate of deep percolation of approximately 280,000 acre-feet per year. Although this deep percolation estimate is based on drainage data that has not been made available to Metropolitan, and while the volume is higher than as estimated by Dr. Rhoades, it is noteworthy that the deep percolation volume is also much lower than as estimated by IID in subsequent years.

Water Balances Prepared For IID In Years After 1985

The water balances prepared by IID (1993) and IID (1994) assumed that tailwater equaled 15.6 percent of farm deliveries. This fixed percentage was based on IID tailwater studies reported in IID (1990), which admitted that the 15.6 percent value was "not statistically 'weighted' to reflect the actual crop percentages that exist in the District." Boyle (1993) assumed a fixed percentage of 16.8 percent tailwater based on the crop-weighted average of the data reported in IID (1990). Deep percolation was then was estimated as the residual of the on-farm water balance. Tailwater for these estimates range from 398,000 to 407,000 acre-feet, with deep percolation ranging from 276,000 to 432,000 acre-feet.

The WST (1998) water balance used tailwater volumes provided by IID at an annual average of 16.7 percent of the volume delivered to farms, which were equivalent to the volumes reported by Boyle (1993). WST noted in its report that IID does not record tailwater volumes and that much of the data from previous studies was lost, and questioned the accuracy and randomness of those previous flow measurement data. The WST balance estimates were 414,000 acre-feet and 425,000 acre-feet for tailwater and deep percolation, respectively.

There is no apparent basis for the tailwater percentages used in water balances conducted in IID (2002) and later by IID's consultant in NRCE (2002), which were presumed as 15 percent and 17, respectively. Tailwater estimates from these water balances range from 386,000 to 426,000 acre-feet and deep percolation estimates range from 331,000 to 417,000 acre-feet.

The common approach in this series of estimates is to first establish the tailwater fraction, and then calculate the deep percolation volume as the closure term. However, the basis for choosing the appropriate initial tailwater fraction is not supported. The initial tailwater fraction is either based on dated studies where the underlying data is lost, or is merely assumed. The assumed initial tailwater fractions are consistently low which, when compared to Rhoades' estimates, result in relatively low tailwater volumes and relatively high deep percolation volumes.

Water Balances Prepared By Bureau Of Reclamation Consultants (Jensen (2002))

In partitioning the volumes of tailwater and deep percolation, Drs. Jensen and Walter noted that use of deep percolation as the residual term does not account for the relatively large variation in annual drainage flows. Drs. Jensen and Walter noted that amount of water infiltrating the soil is limited by soil characteristics and thus, tailwater volumes would be significantly more variable than deep percolation volumes on a year-to-year basis. Drs. Jensen and Walter believed that deep percolation was limited to the amount required for leaching and thus deep percolation volumes were actually far less than previously estimated.

Accordingly, Drs. Jensen and Walter first estimated deep percolation as the amount needed for leaching. Estimated tailwater was assumed to be the residual of the on-farm water balance and, on an annual basis, ranged from 18 percent (501,081 acre-feet) of the volume delivered to the farm to 29 percent (764,221 acre-feet). As discussed above, Dr. Rhoades estimated tailwater and deep percolation using a similar methodology, in addition to his estimates using the chloride mass balance methods. The range of Drs. Jensen and Walter's estimates bracket Dr. Rhoades' estimates.

As previously noted, Dr. Rhoades' estimates using different chloride mass balance approaches were very similar to each other and to Rhoades estimate using his water balance approach. Because the chloride mass approach does not depend on a initial estimation of tailwater or deep percolation to calculate the other volume, a chloride mass balance analysis is free of the bias that may be inherent in judgments incorporated into the water balance approaches. One might expect that IID's estimates are biased toward underestimating tailwater volumes, in order to counter any accusations of waste. Similarly, the assertion by Drs. Jensen and Walter that deep percolation is equal to the amount needed for leaching and similar assertions by Dr. Rhoades could be argued as biased toward overestimating tailwater. However, the unbiased results of the chloride mass balance indicate that actual tailwater volumes are indeed significantly greater than that estimated by IID and its consultants, and very similar to that estimated by Drs. Jensen and Walter and to that estimated by Dr. Rhoades using their water balance approach. This provides further support to the findings that the amount of water infiltrating the soil is limited to a much lower value than has been estimated by IID.

4. IID's Assessment of Current Water Use – The NRCE Report

IID recently released its NRCE Report in an attempt to refute claims of excess and wasteful water use within its service area and to justify its current use of 3.10 MAF per year. Metropolitan's Expert Team and staff analyzed the NRCE Report in detail and found its primary conclusions to be flawed. This analysis and the serious flaws discovered in the NRCE Report are presented at Tab 5 and summarized here.

The NRCE Report based its evaluation of on-farm efficiency on only approximately four weeks of field investigations of only single irrigation events on only seven fields and which were growing only two perennial crops (alfalfa and Bermuda grass). This extremely small and non-representative sample of single summer-period irrigation events on two perennial crops are not typical of irrigation events throughout the Imperial Valley and resulted in biased results reflecting seasonally minimum soil intake rates and minimum deep percolation rates. The calculated efficiencies were then inappropriately extrapolated over the majority of the irrigated lands in the IID to represent irrigations for all crops and all seasons. These efficiencies actually reflect an extremely small fraction of the soils, crops, and seasonal irrigations that make up the IID service area.

The NRCE Report states that tailwater and horizontal leaching are vital, beneficial, and necessary requirements in the IID for salinity control. While the leaching of excessive salts from the crop root zone is essential over time, it is accomplished primarily by the vertical flow of water through the soil, not via surface tailwater flow. The NRCE Report states that tailwater accounts for 43% of the salts leaving the field. This assertion of the effectiveness of tailwater in salt control is grossly exaggerated since nearly all of the salt contained in the tailwater was originally found in the applied water and simply passed across the field without infiltrating the soil. Most of the salt contained in tailwater is not removed from the soil as the NRCE Report claims. Even using the NRCE Report's biased values for tailwater runoff and deep percolation flow, Dr. Rhoades and the Metropolitan Expert Team found that the amount of tailwater flow that contributes to leaching is insignificant.

The NRCE Report incorrectly claims that additional water must also be applied on idle fields to leach salts between plantings. The NRCE Report refers to irrigation of fields between crops as "reclamation leaching." Metropolitan's nationally-renowned team of experts, however, believe that generally, "reclamation leaching" is not required because sufficient leaching occurs during normal pre-plant and early-season irrigations, especially irrigations applied to winter-season annual crops. (This was shown to be the case by studies conducted by Dr. Mark E. Grismer (see Grismer, M.E. (2003) at Tab 6), in which even with tailwater managed to less than about 2 percent of field deliveries, hay yields actually increased over a study period of 3 years. Only a normal, pre-plant irrigation leaching was needed to return soils to pre-study salinity levels.) The NRCE Report did not consider these and other important factors, basing its assessment solely on the same summer irrigation events outlined in above. In order to reach its conclusion, the NRCE Report inappropriately focused on the absolute amount of salts added. However, what is actually relevant is the absolute concentration of dissolved salts in soil that exists within the active root zone during the time the crop is growing. The NRCE Report also miscalculated the amount of salt added to the soil profile from its field evaluations.

Considerable effort was made by the NRCE Report to establish that the cracking clay soils, found in the IID service area, have unique properties making tailwater essential and that these types of soils comprise 87 percent of the IID service area. Contrary to this characterization, such soils in IID are not unique and similar soils are found in other parts of the western United States as well as other parts of the world, where tailwater is not prevalent. In today's irrigation world, design and management practices are widely available to effectively irrigate and leach cracking clay soils, maximizing distribution uniformity while minimizing tailwater. Based on an evaluation of soils information throughout the Imperial Valley, obtained from the Natural Resources Conservation Service, a branch of the United States Department of Agriculture, Metropolitan's Expert Team concluded that cracking clay soils comprise much less than 87 percent of IID's service area. (See Scott, J. (2003a) at Tab 4 and Grismer, M.E. (2003) at Tab 6.) Further, as previously summarized and reported by Dr. Rhoades, the low infiltration rates of heavy cracking clay soils actually improve irrigation uniformity and efficiency, thus allowing for easier application of irrigation methods to reduce tailwater, such as the reduced-runoff method demonstrated by Dr. Grismer (see Grismer, M.E. (2003) at Tab 6).

The NRCE Report incorrectly claims that prevalent irrigation systems and management practices within IID cannot be changed (see NRCE Report, Page VIII-1, fifth paragraph). As discussed by Metropolitan's experts Mr. Harold Payne and Mr. Bruce Brown (see Payne, H. and B. Brown (2003) at Tab 9), numerous simple, low cost on-farm irrigation management techniques are available to growers that can reduce tailwater to 5 percent or less. One of these methods, reduced-runoff irrigation, was proven to be extremely effective on the heavy cracking clay soils of IID as described by Dr. Grismer (see Grismer, M.E. (2003) at Tab 6). Additionally, in its analysis of the data gathered from its fieldwork, the NRCE Report excluded one of the fields it evaluated that, in fact, demonstrated that the application of improved irrigation management practices would reduce tailwater to less than 5 percent and simultaneously provide adequate leaching. (See NRCE Report at IV-15, fifth paragraph [discussing the rationale for excluding Field 5, the data from which is printed in Appendix 7 to the NRCE Report].)

While in recent years IID has been diverting more water than ever, the NRCE Report preposterously claims that due to the cracking clay soils and low infiltration rates the IID farmers have *under applied* between 200,000 to 400,000 acre-feet of water, resulting in lower yields. After a detailed analysis of the NRCE Report, no member of the Metropolitan Expert Team can discern any remotely credible evidence to support this claim. In fact, a comparison of the evapotranspiration as determined in the NRCE Report's water balance analysis (see NRCE Report, Table V-14) to theoretical estimates of potential evapotranspiration based on weather data show that this absolutely is not the case.

In sum, the primary conclusions of the NRCE Report are simply not credible due to inappropriate assumptions, misuse of available data, incorrect and incomplete calculations, and the use of inappropriate methodologies.

5. IID's Claims of Efficiency

Some of the Part 417 factors suggest that certain types of "efficiency" calculations may be appropriate. "Efficiency" here means simply the mathematical relationship between different terms or categories in a water balance. There are different types of efficiency calculations that may be used to evaluate the performance of agricultural operations and irrigation systems, such as "irrigation efficiency," "irrigation consumptive use coefficient," "irrigation sagacity," and "application efficiency."[17] Efficiencies also may be calculated for different parts of an irrigation system, such as "conveyance" efficiency, "on-farm" efficiency, and "district-level" or "project" efficiency. An irrigation project may have a high efficiency value along one dimension of efficiency but a lower value along another dimension.[18] For example, a project may have high levels of conveyance system efficiency but lower levels of on-farm efficiency.

In determining various efficiency measures, the categories or fractions of water in a water model can be broken down (or "partitioned") into the more judgmental categories of "beneficial" or "non-beneficial" and "reasonable" and "unreasonable." These categories involve varying degrees of judgment and subjective evaluation. For example, there is general agreement that certain water fractions in a water balance, such as the amount of water needed for crop ET, soil leaching, and seed germination are "reasonable" and "beneficial" uses because they are necessary to sustain agronomic production as a physical matter. There also is general agreement that, at the other end of the spectrum, water fractions such as excessive tailwater and excessive deep percolation that serve no leaching function are "non-beneficial" and "unreasonable" uses.[19]

In between are certain components or fractions of a water balance that are "non-beneficial" in that they are not needed to sustain agronomic production, but they nonetheless may be "reasonable" because of "imperfections" in farming and irrigation system operations. As previously discussed, for example, some deep percolation in excess of leaching requirements may be necessary because of soils non-uniformity. Some water losses may be unavoidable, as a practical matter, because of inevitable human errors in farm management. These fractions of water may be "non-beneficial" but they still might be treated as "reasonable". Dr. Rhoades' water balance calculations for IID have include water for "non-beneficial" but "reasonable" uses in order to take into account "real world" imperfections and limitations.

With these concepts in mind, we turn to IID's claim that it is "83.3 percent efficient."[20] While IID may use an accepted concept of irrigation efficiency in its calculation (that is, the ratio of the amount of water beneficially used (the numerator) to the amount of water delivered to the irrigator (the denominator)), its resulting values are meaningless. As previously summarized, IID has grossly overstated its "reasonable" and "beneficial" use requirements by claiming leaching and other requirements that far

[17] See Burt, C.M, et al, "Irrigation Performance Measures: Efficiency and Uniformity", *Journal of Irrigation and Drainage Engineering*, pp. 428-433 (November/December 1997); Burt, supra, "Irrigation Water Balance Fundamentals," pp. 8-9.

[18] See Burt, supra, "Irrigation Water Balance Fundamentals," pp. 8-9 (describing how Westlands Water District's district-level efficiency is higher than its on-farm irrigation efficiency, whereas, IID's district-level efficiency is lower than its on-farm irrigation efficiency.)

[19] See Burt, C.M, et al, "Irrigation Performance Measures: Efficiency and Uniformity", supra, p. 428.

[20] For the determination of this irrigation efficiency calculation, see, e.g., NRCE Report at p. IV-30.

exceed its actual needs. Specifically, the NRCE Report asserts that the normal leaching requirement within IID is 338,000 acre-feet per year (263,000 acre-feet vertical leaching and 75,000 acre-feet horizontal leaching; see NRCE Report at IV-30). However, Dr. Rhoades and Metropolitan's expert team determined that the actual amount required for leaching and including an allowance for real world imperfections is about 197,000 acre-feet, a difference of 141,000 acre-feet.[21] Thus, calculations of efficiencies mean nothing if the underlying estimates of "reasonable" and "beneficial" use are erroneous. In short, garbage in--garbage out.

The Part 417 regulations also identify the "amount and rate of return flows to the river" as a relevant factor. This suggests that the appropriate efficiency calculation should take into account the ability of others to reuse "excess" or "surplus" water flows from IID. That is, a true efficiency measure should take into account whether water is available for further beneficial consumptive use or is lost to the system forever. Thus, if drainage or "surplus" water cannot be used by others and is lost to the system, then a higher level of efficiency is generally required under the doctrine of beneficial use. If drainage or surplus water returns to the stream and can be reused, it is less important to require higher levels of efficiency because the excess water is still available for beneficial use by others.

Accordingly, Metropolitan estimated the "beneficial use fraction" of IID's use of water from the Colorado River. This measure is simply the ratio of beneficial use over the net total water use, with beneficial use represented as water diverted for crop evapotranspiration, leaching, and other non-agricultural beneficial uses. Assuming the beneficial use components of IID's net diversions are equal to the sum of crop evapotranspiration satisfied with delivered Colorado River water, estimated water used for leaching, and non-agriculture deliveries as reported by DOI/BOR in Jensen (2002), the fraction of Colorado River water beneficially used in IID is only 69 percent. Thus, with appropriate recognition that none of the water delivered by IID and used by its customers can ever be put to beneficial use again, IID's "efficiency" drops dramatically. This efficiency rating for IID is also in sharp contrast to other agricultural entities served by water from the Colorado River where, because of return flows, non-beneficial losses of water are limited. For example, for Yuma Irrigation District and Palo Verde Irrigation Districts, Metropolitan calculated beneficial use fractions of 99 and 98 percent, respectively.

[21] As discussed at Tab 5, IID's assertion that additional water (138 KAF) is required for reclamation leaching in-between crops for soil salinity control is incorrect. No evidence was provided to indicate that such reclamation leaching is actually practiced in the IID water service area at a significant level. Indeed, IID (1996) reported that during the 1987-94 period, the annual average "reclamation leaching" volume was 16,265 acre-feet. Based on this IID data, approximately 112 KAF of water that was claimed in the NRCE Report to be used for reclamation leaching was discharged to drains as pure waste. Thus, by including this volume in the amount actually discharged as tailwater, the total NRCE tailwater volume would be 548 KAF.

6. IID's Reasonable Beneficial Colorado River Water Use Needs

As noted by Dr. Rhoades in his memorandum, the Metropolitan Expert Team believe that IID's reasonable beneficial water use needs should target a reduction in tailwater water waste equal to no more than 5 percent of deliveries to the field.

As summarized by Dr. Rhoades, IID's water use requirement as he calculated for the 5 percent tailwater condition is an appropriate target value for IID and is supported by the observations that: (1) field studies have successfully demonstrated that alfalfa and Sudan can be successfully produced in high clay content soils of the IID with tailwater runoff less than 5 percent using simple "reduced-runoff" irrigation systems (Grismer, M.E. (2003)); (2) alfalfa, wheat, sugar beets and cantaloupes have been successfully grown in high clay content soil in the IID without any tailwater runoff using level basin irrigation and under conditions of abnormally high levels of irrigation water salinity (Rhoades, et al., 1988); (3) Boyle Engineering (1993) concluded that it was practical to reduce tailwater to about 5 percent using tailwater recovery systems; (4) Dr. Wynn Walker concluded from his surface-irrigation simulations that it was practical to achieve 95 percent irrigation infiltration uniformity in the high clay content IID soils using blocked end irrigation systems (Walker, W.R. (2003a, 2003b)); (5) Mr. Harold Payne concluded from his field observations and evaluations of the IID situation and Arizona experience that it was practical to reduce tailwater to 5 percent with only management changes and relatively inexpensive systems changes (Payne, H. and B. Brown, (2003)); (6) the leaching fraction being achieved in the IID over the 1989-96 period was only about 0.09 (Rhoades, J.D. (2003b)) and crop yields appear to be good at this level of leaching (Gabrielsen, B.Y. (2003)); and (7) the results of the chloride mass balance assessments that suggest that the low permeability of the IID soils may impose a limit on infiltration and thus improve irrigation uniformity.

As previously shown in Table 1, Dr. Rhoades' calculation of the on-farm reasonable beneficial use requirement for IID equates to 2.568 MAF per year in diversions from the Colorado River at the Imperial Dam without considering opportunities for conservation of conveyance system losses. As discussed in Section IV.C, numerous system conservation measures which can save approximately 200,000 acre-feet in total diversions have already been approved for implementation, such as the lining of the All-American Canal, or have been identified and studied. When these measures are considered, IID's reasonable beneficial use needs are no more than 2.368 MAF per year in total diversions.

B. Historical Water Usage

In prior papers and submissions, IID has asserted that the amount of Colorado River water it wants to divert and use in 2003 is on par with the amount of water it has diverted and used in the past. Indeed, IID has gone to great lengths to explain its historical usage of Colorado River, which has increased by over 300,000 AF from the level of use that occurred in the 1970s and 1980s. See IID Litigation, Declaration of Rodney T. Smith In Reply To Oppositions By Federal Defendants and Intervenors To

Imperial Irrigation District's Motion For Preliminary Injunction [hereinafter "Smith Declaration"]; Scott Memorandum (2003b).

Yet, as discussed at length in Section II, the amount of Colorado River water IID has been allowed to divert and use in the past is not determinative of how much Colorado River water it should be allowed to divert and use in future. In that regard, what IID fails to discern (or simply ignores) is the distinction between an explanation and a justification. While it may be possible to explain IID's historical usage, it cannot be justified. See Section IV.A. supra (noting that IID's current water requirements require no more than 2.368 MAF per year in total diversions).[22]

Nonetheless, as the Part 417 regulations indicate, historical usage is one factor that can be used in assessing current water needs. See 43 C.F.R.§ 417.3. But here what such usage indicates is that in the past decade IID has significantly increased its diversions of Colorado River water for no legitimate reason. From the data reported in the memorandum prepared by Mr. John Scott, IID's historical net diversions[23] of Colorado River water at Imperial Dam averaged 2.78 MAF from 1975 to 1989. (See Scott, J. (2003b) at Tab 4.) However, In 1994, IID's historical net diversions jumped to 3.05 MAF and has averaged 3.11 MAF since that time. In terms of total diversion, IID's average for the period from 1994 to 2002 is 3.19 MAF.[24] Conservation projects that have been phased in since 1990 under the IID-MWD Water Conservation Program presently are saving approximately 105,000 AF per year.

This increase in diversions cannot be explained by any changes in crop-related factors, such as cropping patterns, yield trends or evapotranspiration (ET) demands. As discussed by Dr. Byron Gabrielsen in the attached memorandum, none of these factors has changed in a way that would be expected to increase water needs within the district. See Gabrielsen, B.Y. (2003) at Tab 7).

Based on his analysis of existing data, Dr. Gabrielsen found that:

1. IID's method of acreage compilation has consistently overstated the total cropped acreage. This, in turn, has resulted in highly exaggerated estimates of ET demand within the district.

[22] Again, this is a conservative estimate that takes into account certain factors, such as tailwater runoff, leaching requirements and field non-uniformity, that *increases* this figure, but does not take into account certain approved and/or identified distribution system conservation measures, such as lining of the All-American Canal, that would *decrease* this figure. As noted before, if such conservation measures are factored in, IID's beneficial use needs drop to 2.368 MAF per year.

[23] "Net diversions" or "consumptive use diversions" refers to the actual consumptive use or depletion of water from the Colorado River by IID and is equal to the amount diverted at Imperial Dam minus return flow back into the river.

[24] To equate net diversions to total diversions, the return flow credit must be added. As described by Mr. Scott, this amount is assumed by DOI/BOR to be 3.2% of the net diversion. (See Scott, J (2003b) at Tab 4.)

2. Total cropped acreage within the district has trended downward, particularly in recent years. This shows that recent increases in net diversions from the Colorado River have not occurred in response to any increase in the number of acres being farmed.

3. Yield trends within the Imperial Valley from 1990 to 2001 have remained steady or have trended upward for most of the primary crops grown, while ET demand has remained relatively steady. Thus, any claim by IID that increased diversions are needed to sustain or improve crop yield is without merit.

Gabrielsen Memorandum, pp. 1-2.

Accordingly, Dr. Gabrielsen concluded that "ET demand within the district service area is less that what IID claims" and that "changes in net diversion of Colorado River water into the IID service area cannot be adequately explained by the observed changes in total cropped acreage or the level of crop production (yields) that has occurred in the past several yields." Id.

Notwithstanding such data, IID steadfastly maintains that its excessive use of Colorado River water can be explained. Relying on a model that would make Rube Goldberg proud, IID's economic consultant, Dr. Rodney Smith, concludes that historical usage of water within the district correlates very closely with such factors as annual rainfall, cropping patterns, economic conditions, water salinity and insect infestation. See Smith Declaration, Ex. B, p.9.

However, as explained in the memorandum prepared by Dr. Richard E. Howitt, there are several major problems with Dr. Smith's analysis. See Tab, 8, Memorandum from Richard E. Howitt and Siwa Msangi, University of California at Davis, to Kirk Dimmitt, Principal Engineer, Metropolitan (May 28, 2003) [hereinafter "Howitt Memorandum"] (analyzing Dr. Smith economic model).

First, Dr. Smith attempts to use an economic model to explain the physical needs of crops within IID. Economic conditions within the district have no bearing on how much water is required to support the types and acreages of crops being raised. Simply put, plants don't care whether its a bull market or a bear market. Once again, this highlights the fact that IID is attempting to explain its water usage, rather than justify its water needs.[25]

Second, as noted in Section IV.A, Dr. Smith could just as easily have correlated growth in water use in Imperial Valley to growth in SUV ownership. Given the right selection of variables, almost any historical trend can be explained. But "correlation" and "causation" are not the same thing. Merely because certain factors

[25] In fact, a far more likely "economic" explanation for this increased water usage is IID's desire to pad its entitlement to Colorado River water so that it can later "conserve" such water for sale to holders of junior priority rights, such as Metropolitan.

correlate with IID's historical usage does not mean that those factors caused such usage to occur in past or will cause such usage to occur in the future.

Third, the economic model used by Dr. Smith in fact does not demonstrate that there is a high correlation between IID's historical usage and the variables of annual rainfall, cropping patterns, economic conditions, water salinity and insect infestation. As stated by Dr. Howitt:

> Dr. Smith's estimation incorrectly uses linked (endogenous) variables to explain IID water use. When standard statistical measures are used to correct for the mistake, the explanatory ability of the model falls dramatically. Dr. Smith claims that his model explain 90.9% of the variation in water use (page 18). When estimated correctly, the proportion of the variation of water use explained by the model falls to the inconsequential level of 48.4% of the variation.

Howitt Memorandum, p. 1.

Thus, Dr. Howitt concludes:

> [W]e have found that Dr. Smith has failed to produce a statistical model that can reasonably explain usage of water in Imperial Valley. Mis-specifying his statistical model and ignoring the serious statistical problems creates a bias in his results that causes him to greatly overstate the explanatory power of his regression model and its ability to fit the observed pattern of water usage in Imperial Valley. *As such, his model results cannot be used to estimate the impact of any one of his explanatory factors on overall water usage, or to reliably predict future water usage in Imperial*.

Howitt Memorandum, p. 10 (emphasis added).

In short, there is no legitimate reason or explanation why IID has "pumped up the volume" of diversions from the Colorado River over the last ten years. In fact, if IID's historical water usage since 1993 demonstrates anything, it is that an immediate reduction in diversions is both feasible and warranted.

As discussed in Section IV.A, Metropolitan strongly believes that IID's current beneficial use needs justify only 2.368 MAF per year in total diversions from the Colorado River at the Imperial Dam. Moreover, as discussed in Section IV.C., Metropolitan believes that there are a host of steps IID can take to reduce its usage to these levels within the next five years.

Nonetheless, Metropolitan understands that it may not be practical for IID to reduce its diversions to 2.368 MAF in 2003. However, IID can and should be required to reduce its total diversions of Colorado River water to 2.81 MAF for calendar year 2003.

This is essentially equivalent to the average amount diverted prior to 1993, which was more than adequate to meet IID's beneficial use needs at that time. In the absence of any change in cropping patterns, yield trends, ET demands or other relevant factors clearly demonstrating that such needs have increased, there simply is no reason why IID should be allowed to divert any more than this amount at this time.

C. Future Water Conservation

As demonstrated in the previous section, reducing IID's Revised Water Order by at least 300,000 acre-feet for 2003 would provide IID with essentially the same amount of water it historically received during the 1970s and 1980s. Nothing has changed to explain IID's higher use today. However, it is during this period and at this lowered level of diversions that the SWRCB found IID to be wasting water. Consistent with the SWRCB findings and those of Metropolitan's expert team regarding IID's current water needs, there remains considerable water conservation opportunities beyond an immediate cut of at least 300,000 acre-feet.

Opportunities for water conservation are appropriate factors to consider in assessing reasonable beneficial use and waste. See, e.g., Pyramid Lake at 257 ("better management … would prevent unnecessary waste"). Similarly, advances in irrigation technology and management that make greater water use efficiencies possible may be considered in determining reasonable beneficial muse needs. With such advances, irrigation practices that might have been acceptable in the 19th Century, become entirely unacceptable in the 21st Century. See, e.g., Vineyard Land & Stock Co. v. Twin Falls Oakley Land & Water Co., 245 F. 9 (9th Cir. 1917) (finding that older, less efficient "flooding" method of irrigation was not a proper a measure of an irrigator's water duty or, in turn, its reasonable beneficial use needs.) But once waste has been found, as it has been found here, it is not necessary to demonstrate the feasibility or expense of curtailing that waste. As the SWRCB explained, "The fact that water conservation may require the water user to incur additional expense provides no justification to continue wasteful or unreasonable practices." Decision 1600 at 27.

Notwithstanding that the case of IID's waste and unreasonable use has already been made, the following describes some conservation methods which can be employed to eliminate the waste and unreasonable use of water on IID lands. These include the measures identified by the SWRCB in its finding of waste; enforcement of rules and regulations to control excessive tailwater; simple on-farm irrigation management practices that are not only economically feasible to growers, but economically beneficial; and numerous system conservation measures that have already been identified or are already being implemented.

1. SWRCB Findings of Waste and Conservation Opportunities

In Decision 1600, the SWRCB concluded that IID's failure to implement additional water conservation measures at the time was unreasonable and constituted a waste of water. The SWRCB found that curtailing excessive tailwater was one of several opportunities to conserve, and ordered IID to develop a water accounting and monitoring procedure which would result in quantifying the following with reasonable accuracy: (1) actual deliveries to farmers headgates; (2) tailwater; (3) canal spills; (4) canal seepage; and (5) leachwater. Decision 1600 at 68. In its order affirming Decision 1600 and denying petitions for reconsideration, the SWRCB noted that "the inability of the District to account for the large quantities of water losses in District operations is itself evidence that the District's existing water management practices are unreasonable." In the Matter of Alleged Waste and Unreasonable Use of Water by Imperial Irrigation District, SWRCB Order WR 84-12 at 20 (Sept. 1984).

Subsequently, the SWRCB issued its Order WR 88-20, dated September 7, 1988, in which the SWRCB concluded:

> The need for substantial additional water supplies in California and the prospects for substantial water conservation in IID have been well established. Development of a definite schedule and implementation plan for conserving at least 100,000 acre-feet per annum should be regarded as an initial step in developing and implementing an overall water conservation program which will assist in meeting identified needs. Based on presently available information, the Board finds that conservation of 367,900 acre-feet per annum as proposed in IID Exhibit 25 is a reasonable long-term goal which will assist in meeting future water demands.

SWRCB Water Rights Order WR 88-20 at 44.

IID estimated (in its Exhibit 25, cited by the SWRCB in the above passage) that implementation of proposed programs with a number of water conservation elements would conserve 367,900 AF per year.[26] (As shown in the previous section, IID's water use at that time averaged about 2.8 MAF, the same as it would be now with an immediate reduction of 300,000 acre-feet from its Revised Water Order. This suggests that IID had estimated its true water needs to be about 2.4 MAF (2,800,000 AF – 367,900 AF), essentially the same reasonable beneficial use number as calculated by Metropolitan's Expert Team.)

In addition, IID "pledged" to the SWRCB, in a September 29, 1982 letter, that it would construct one regulating reservoir per year until a total of 20 to 22 reservoirs were in operation. In Decision 1600, the SWRCB ordered IID to submit, by February 1, 1985, a plan to resume regulating reservoir construction as guided by IID's earlier pledge to construct one reservoir per year. Decision 1600 at 69. Then in WR 88-20 the SWRCB ordered IID to conserve a total of 100,000 AF per year by January 1, 1994, of which 20,000 AF per year was to be conserved by January 1, 1991. SWRCB WR 88-20 at 44-45.

[26] A copy of IID Exhibit 25 entitled Water Conservation Program Implementation Plan, March 1988, was submitted by Metropolitan in the IID Litigation as Exhibit 4 to the February 21, 2003 Declaration of Arnold K. Dimmitt.

As noted by Metropolitan Principal Engineer Arnold K. Dimmitt in his March 6, 2003 Supplemental Declaration submitted in the IID Litigation, to date, over 18 years after the SWRCB's order, a total of only 10 regulating reservoirs have been constructed; five of which were funded by Metropolitan under the IID/MWD Conservation Program. And as clearly shown in the preceding section, IID's water use has gone up since then, not down.

2. Rules and Regulations Regarding Tailwater and Waste

The most effective, immediate, and cost effective way to reduce the excessive tailwater is for IID to enforce their Rules and Regulations Governing the Distribution and Use of Water ("Rules and Regulations").[27] These Rules and Regulations for prevention of excessive tailwater include:

- Regulation 17 - Excessive Ponding and Wasting Water: This regulation essentially prohibits any excessive ponding of water in the lower ends of fields and discharging such excessive irrigation water into the drainage systems, IID or private. IID can refuse or restrict water service to any landowner or water user who does not comply. Rules and Regulations at 16.

- Regulation 39 - Agricultural Tailwater Structures: This is to standardize the tailwater structure to serve as a drainage structure while facilitating a reasonably accurate measurement of the drainage discharge and preventing manipulation of flow out of the structure. The water user is responsible for maintaining the tailwater structure and approach channel in acceptable condition in order to receive delivery of water. Rules and Regulations at pp. 44-46.

- Regulation 45 - Tailwater Assessment and Delivery Adjustment to Conserve Water: Based on certain conditions of water delivery and measurement and irrigation practices, IID shall levy an assessment against all tailwater discharges over 15 percent of the water being delivered. The assessment is equal to the quantity of excess water charged times the scheduled water rate multiplied by three. Should it become necessary to levy assessments against discharges on subsequent irrigation runs for any one delivery gate in a calendar quarter, each successive assessment multiplier is increased by one (i.e. 4, 5, etc.). Rules and Regulations at pp. 50-52.

Thus, IID has the regulatory enforcement and control mechanisms in place to immediately begin reducing the substantial volumes of excessive tailwater waste flowing from fields in its service area. As previously described in Section IV, Dr. Rhoades

[27] A copy of IID's current Rules and Regulations IID was submitted by Metropolitan in the IID Litigation as Exhibit 7 to the February 21, 2003 Declaration of Arnold K. Dimmitt.

calculated IID's total diversion requirements at the 15 percent tailwater condition as 2.8 MAF. Thus, with a reduction of 300,000 acre-feet from its Revised Water Order, IID will have enough water to meet all of its crop ET and leaching requirements, will have an extra allowance of water for irrigation inefficiencies, and will still be able to allow excess tailwater to flow at rate of 15 percent of the deliveries to the field, from *every* field in its service area. And all it needs to do to get there is simply begin enforcing its own Rules and Regulations.

As described by Metropolitan Principal Engineer Arnold K. Dimmitt in his February 21 Declaration submitted in the IID Litigation, IID does not regularly enforce its Rules and Regulations on excessive tailwater. As he also described, because of the lack of enforcement within IID, a "Tailwater Assessment Project" was included in the original water conservation agreement entered into between IID and MWD in 1988 (the "IID/MWD Water Conservation Agreement" signed in December 1988). This project was a system-wide water management practice entailing expanded enforcement of IID's existing "Regulation 45" assessment and triple charge program by adding more staff to carry out the program. The proposed expansion would have added an estimated 18 staff to permit increased surveillance of the tailwater in the valley to enforce the regulation. However, at the insistence of IID, this project was removed from the IID/MWD Conservation Program during negotiation of the 1989 Approval Agreement.

IID has not always failed to enforce its tailwater regulations, and periods where the regulation was actively enforced show enforced show a marked reduction in IID's water diversions. As described by Metropolitan Engineer John Scott (see Scott, J. (2003c) at Tab 4), IID documents indicate that its staff actively and increasingly enforced the Regulation 45 soon after its adoption. The level of enforcement increased steadily through 1982, and then increased dramatically in 1983. By 1987, over 90 percent of the normal irrigations were monitored. But in each year following 1987, IID documents depict a decreasing level of enforcement.

During the 12-year period from 1976 through 1987 when IID was increasing its enforcement of Regulation 45, IID's annual average net (consumptive use) diversion was about 2.72 MAF, the lowest 12-year average since 1960. Had the conservation measures implemented under the IID-Metropolitan water conservation program been in place during this period, IID's net diversions would have averaged approximately 2.66 MAF. During this period the annual average area irrigated, including multiple cropped acreage, exceeded that of the annual average for 1994 through 2001.

While the IID's Rules and Regulations may provide a mechanism for curtailing the diversion of 300,000 acre-feet in 2003, Metropolitan and its team of experts do not agree that allowing 15 percent of tailwater waste represents an acceptable beneficial use. Numerous irrigation, water, and conservation districts do not permit excessive surface waters (tailwater, return flows, runoff) to leave the farm and/or the district. Some districts capture any such surface flows and reuse such while others impose fines and will terminate water service. A few examples of such rules are:

- Hills Valley Irrigation District: "There are no operational spill losses in the District. All water transmitted within the District's distribution system remains within the system until utilized. On-farm tailwater return systems have been constructed by those landowners not utilizing permanent on-farm distribution systems. All deep percolation losses return to a usable groundwater source and no water leaves the service area in the form of surface runoff."

- Glide Water District: "No return flows are allowed to leave the district. Glide Water District oversees the operation of the last recovery system within the district to avoid any tailwater spill."

- Panoche Water District: "The District, which is part of Panoche Drainage District, requires that all return flow be retained on farm and be managed by each water user. Tailwater management may consist of using that water on adjacent field by the same water user, or releasing that water for use by other water users. Discharge of tailwater into the Panoche Drainage District system is not allowed. In some cases, the District can accommodate tailwater into the supply channels as long as it is free of silt and debris. The District has no operational spill."

- Sausalito Irrigation District: "All water used with the District stays within the District. Many farms have return systems to allow for tailwater reuse. There are no operational spill losses in the District."

These agricultural districts recognize that losses of water such as the occurring in IID through excessive tailwater – even at a 15% limit – constitute waste.

3. On-Farm Irrigation Management Measures

Tailwater is not unique to IID; many other irrigated areas have identified its occurrence as wasteful and have developed a variety of conservation measures to reduce and/or eliminate its occurrence. In their report, Metropolitan Expert Team members Mr. Harold Payne and Mr. Bruce Brown identify and summarize a number of proven and available irrigation management practices that can be quickly and easily implemented by IID growers with the aim of reducing tailwater runoff district-wide to 5 percent or less. (See Payne, H. and B. Brown (2003) at Tab 9.)

Because the list of available measures is large, Mr. Payne and Mr. Brown selected several conservation measures from Best Management Practices publications of public agencies, from files of irrigation engineers and consultants, and from personal on-farm experience that appear to have applicability in IID. These conservation measures can be placed into two general groups: one group relying on low-cost management techniques, such as precision timing of irrigation water cutoff and matching water applications to soil intake rates; and the other using field designs, structures or equipment, such as leveling fields or installing pump-back systems to improve irrigation application efficiency. Mr. Payne and Mr. Brown focused their investigation techniques in the first group; specifically, the following irrigation management measures that can be implemented in the short-term:

- Precision irrigation cutoff (Reduced-Runoff Practice)
- Cutback irrigation (Border Strip Irrigation)
- Blocked ends
- Cutback irrigation (Furrow Irrigation)
- Furrow dams
- Soil surface conditioning
- Furrow or bed shaping
- Angled furrows
- Alternate furrow irrigation

a) Costs and Benefits to Growers

Mr. Payne and Mr. Brown concluded that each of the nine measures would result in net benefits to grower and, at the same time, significantly reduce tailwater. All of the nine management measures are low-cost and do not require extensive management training or costly physical modifications of farm fields.

All of the measures have been utilized by irrigation managers in other farming areas and have proven to be effective in either eliminating or greatly reducing tailwater losses and improving irrigation efficiencies.

Table 2 summarizes the estimated costs to implement short-term management conservation measures in IID as estimated by Mr. Payne and Mr. Brown. As can be seen, each of these measures requires only a minimal investment that would be readily recovered through reduction in water use, usually within a year. Also, the last column shows that application of these methods affords substantial potential for significant reductions in tailwater over and above the amounts needed to offset the additional costs of implementation. Mr. Payne and Mr. Brown believe that these practices are compatible with conditions in IID and can be readily implemented to reduce tailwater losses.

Table 2
Estimated Costs for On-Farm Irrigation Management Measures

Management Conservation Measures	Costs ($/acre/year)	Required % Change in Tailwater to Cover Costs	Minimum Expected Tailwater % With Method
Border Strip Irrigation Techniques:			
Precision Cutoff (Reduced-Runoff)	$4.00	25% to 20%	5%
Cutback	$4.00	25% to 20%	5%
Blocked Ends	$0.35	25% to 20%	5%
Furrow Irrigation Techniques:			
Cutback	$6.70	25% to 14%	5%
Furrow Dams	$3.70	25% to 20%	5%
Soil Surface Conditioning	$0.51	25% to 24.4%	10%
Bed-Shaping	$0.84	25% to 24.4%	10%
Angled Furrows (Curved Furrows)	$2.56	25% to 24.4%	0-5%
Alternate Furrow	$(7.73)	0%	10%

The significant cost savings raise the question of why there has been a lack of wide-spread adoption in IID of the available low-cost on-farm irrigation management measures. As explained by Metropolitan economic expert Dr. Howitt (see Howitt, R.E. and S. Msangi (2003) at Tab 8), the answer is clear: the expectations of future water sales revenues. Dr. Howitt maintains that there is a strong rational incentive for farmers not to adopt water reducing on-farm conservation methods that would reduce their potential water rights, and thus their potential share in any future revenue streams from water sales.

Mr. Payne and Mr. Brown also identified other practices, more suited for the long-term, which can be used to physically modify the fields to either completely eliminate tailwater runoff, or to limit it to small amounts. These practices range from small-scale laser-grading projects performed within individual field borders, to tailwater recovery systems, to leveling the entire field or installing drip irrigation systems.

IID's economic consultant, Dr. Rodney Smith, ignored the low-cost on-farm irrigation management measures in his analysis of the economic effects of increased water efficiency in the Imperial Valley. Dr. Smith selected costly tailwater recovery systems as the "benchmark technology" for the cost of conservation in IID. But as noted by Metropolitan's economic expert Dr. Howitt, by over looking the simplest and cheapest alternatives, Dr. Smith is not following the conventional economic approach of marginal analysis. Nonetheless, even if one were to assume tailwater recovery systems as the starting point, Dr. Howitt has shown that Dr. Smith has failed to follow basic tenets of micro-economic analysis; thus, even at the higher costs of conservation assumed by Dr. Smith, none of the doomsday economic impacts he forecasts in fact would occur.

b) Applicability of On-Farm Irrigation Management Measures on IID Lands

In the NRCE Report and other submissions, IID has claimed that lands in its service area have unique soil properties, rendering tailwater essential and thus the simple irrigation management measures identified by Metropolitan's experts are not applicable. This claim is refuted by irrigation simulation modeling using real-world field data and by extensive field tests on precisely the type of lands IID claims to be "unique."

As presented at Tab 3 (see Walker, W. (2003b, 2003c)), Metropolitan Expert Team member Dr. Wynn Walker simulated irrigation events using a computer model known as "SIRMOD" on the test fields used in the NRCE Report. After Dr. Walker's calibrated his model to the data collected in the NRCE Report, he then redesigned the fields and/or managed the irrigation events to allow no more than five percent tailwater losses, improve the leaching opportunity of the irrigation, and to limit field reorganization costs to a practical level. The subsequent simulations showed that with the simple irrigation management measures identified by Metropolitan's experts, it is possible to meet these criteria on IID farms at a reasonable cost.

An evaluation of application of the Reduced-Runoff (or "Precision Irrigation Cutoff') surface irrigation method to alfalfa and sudangrass hay production through a three-year production cycle (1996-98) in the Imperial Valley was conducted by Metropolitan expert Dr. Mark E. Grismer at the University of California Desert Research Center to assess the potential for reducing tail-water runoff. This evaluation is summarized at Tab 6. At the onset Dr. Grismer and his team anticipated possible yield reductions of as much as 30% based on traditional salt-tolerance parameters. However, during the nearly three-year growing cycle, hay yields were greater than county averages and hay quality was consistent with that measured elsewhere. Moreover, total tail-water runoff was minimal, less than 2 percent of the applied water.

Dr. Grismer has concluded that the Reduced-Runoff irrigation method is potentially applicable to all border-irrigated heavy cracking clay soils within IID which comprise about 62 to 69 percent of the Imperial Valley soils. Moreover, the method can be readily applied to border-check irrigation of crops grown on mildly sloping fields that are found across more than half of the IID area.

4. Other Conservation Opportunities

The excessive waste of water occurring in IID is not just the result of poor on-farm management, but also from lateral spills, seepage, and other incidental losses associated with IID's delivery system. Eliminating excessive conveyance system losses can be achieved through a combination of proper management and infrastructure improvements to achieve efficient operations; operations which would provide a relatively consistent and accurate volume of delivered water as ordered and the flexibility to make changes as conditions change. Infrastructure improvements (such as regulating reservoirs and automation of lateral headgates and lateral check gates) can help achieve efficient delivery system operations and eliminate waste.

Since the early 1980s, a number of investigations have been undertaken that identified opportunities for water conservation from IID's delivery system. Numerous system conservation measures have been identified and studied including:

- All-American Canal Lining Project
- Canal lining within IID's distribution system
- Improved flow monitoring structures
- Non-leak gates
- Prevention/recovery of canal spills
- Regulating reservoirs
- Seepage recovery
- System Automation

To quantify the available system conservation opportunities remaining in IID, Metropolitan staff reviewed and analyzed previously identified system conservation measures. Specifically, as described by Mr. John Scott (see Scott, J. (2003d) at Tab 4), the following published investigations were considered:

- Department of Water Resources; December 1981; *Investigation Under California Water Code Section 275 of Use of Water By Imperial Irrigation District*

- U.S. Bureau of Reclamation; July 1984; *Water Conservation Opportunities: Imperial Irrigation District, California*

- Parsons Water Resources, Inc.; 1985; *Water Requirements and Availability Study for Imperial Irrigation District*

- State Water Resources Control Board Order WR 88-20 issued September 7, 1988

- Imperial Irrigation District; January 2, 1996; *Draft Water Requirements and Availability Study*

- Natural Resources Consulting Engineers, Inc.; March 2002; *Assessment of Imperial Irrigation District's Water Use*

- Jensen, Marvin E., Walter, Ivan A.; November 2002; *Assessment Of 1997-2001 Water Use By The Imperial Irrigation District* (including errata sheet dated January 31, 2003)

Metropolitan identified 193,000 acre-feet of system conservation opportunity that is available to IID. This amount consists of the approved All-American Canal Lining Project, which would conserve 67,700 acre-feet, and 125,300 acre-feet of distribution system conservation opportunity. After adjustment for return flows, implementation of the identified system conservation measures would result in reduced IID diversions of approximately 200,000 acre-feet.

V. CONCLUSIONS AND RECOMMENDATIONS

For the reasons discussed above, Metropolitan urges DOI/BOR at a minimum to limit IID's total diversions of Colorado River to no more than 2.8 MAF for calendar year 2003. Furthermore, Metropolitan urges DOI/BOR to require IID to implement a tailwater monitoring program with the aim of reducing IID's diversions to the amount that is truly required to meet its reasonable and beneficial needs -- 2.368 MAF per year. This tailwater monitoring program that should contain the following elements:

- The tailwater monitoring program should be statistically representative of the geographic locations, crops and soils in the IID service area.
- Individual tailwater measurements should be made on clearly identified fields and cover all of the irrigations on a field that season.
- While there is no need to employ exotic or expensive flow measuring devices, tailwater measurement devices used should be calibrated to ensure a reasonable level of accuracy.
- The tailwater monitoring program should include an irrigator advisory service that would assist the irrigator control or eliminate tailwater through specifically applicable management practices and available low-cost technologies.
- In order to minimize contention surrounding this program and minimize or eliminate challenges to it authenticity, the annual selection of fields should be approved by an external review board comprised of experts in on-farm water management and hydography, the irrigators, IID, and DOI/BOR.
- Chloride data needed to undertake an independent mass balance assessment of tailwater and deep percolation volumes should also be undertaken simultaneously.

Failure or refusal to implement the necessary monitoring programs should result in annual reductions to IID designed to reach a true beneficial use amount over a reasonable period of time. This phased-in approach to limitations on IID's water use is actually quite generous and allows for careful calibration as new information becomes available.

Implementation of the above recommendations is not only legally required and morally compelled, but entirely reasonable. As DOI/BOR noted in the IID Litigation, "the era of limits on use of water in the lower Colorado River Basin has finally arrived." The demand for water from the Colorado River now far outstrips the supply. As a result, California and <u>all</u> her citizens must learn to make do with the 4.4 MAF of Colorado River water allotted to it pursuant to the Supreme Court's 1964 Decree.

Stated another way, the era of indiscriminate use of Colorado River water by IID must end. This water is too precious a resource to allow IID to continue wasting it through inefficient use and poor management. In short, IID's water use order simply <u>cannot</u> be based on "business as usual."